



## Exploring Anatomical Variations of the Left Renal Vein: Insights from Cadaveric and Radiological Analysis

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*(Received: 16 September 2024*

*Revised: 11 October 2024*

*Accepted: 04 November 2024)*

### KEYWORDS

Retroaortic renal vein, Inferior venacava, Left renal Vein, Computed Tomography CT scan.

### ABSTRACT:

**Background:** Variations have been noticed in the course and termination of renal veins. The knowledge of these variations is essential in cases of renal vascular surgeries. The objective of the present study was to identify the abnormal course of the left renal vein as it passes from the hilum of the left kidney to terminate in the inferior vena cava.

**Materials and Methods:** This cross-sectional study was carried out in the department of anatomy in a south Indian medical college. The course of left renal vein was studied in 60 human embalmed cadavers. The length of the left renal vein was measured, and if found to follow an anomalous course, the distance of the opening of its tributaries, from the hilum were noted. We also reviewed 100 abdominal CT scan reports to look for retro aortic left renal vein anomaly. The CT scan reports belonged to patients with urological symptoms which included, abdominal and flank pain, dysuria and hematuria.

**Results:** Out of the 60 cadavers, in 58 (96.66%) cadavers, the left renal vein followed the normal course, where it traversed in front of the aorta and terminated in the inferior vena cava in an orthotopic position. The retro aortic left renal vein was observed in two (3.33 %) of the cadavers. In one cadaver, the anomaly was found to be type 2 retro aortic left renal vein. In another cadaver, there was a rare anomaly not reported till date, where the left renal vein coursed obliquely downwards and caudally behind the aorta and divided into two tributaries. The upper branch drained into the inferior vena cava while the lower branch terminated at the junction of the inferior vena cava and left common iliac vein. In the CT scan report study, we found that reports of two patients showed retro aortic left renal vein, and both belonged to the type 1 variety of left renal vein.

**Conclusion:** This study reinforces the importance of recognizing left renal vein variations in clinical and surgical contexts, by highlighting the prevalence and clinical significance of these anomalies, we contribute to the broader understanding necessary for improving surgical outcome and better patient care

### INTRODUCTION

The large renal veins lie anterior to the renal arteries and open into the inferior vena cava almost at right angles.<sup>[1]</sup>

The normal anatomical course of the left renal vein

(LRV) from the kidney to inferior vena cava (IVC) is usually preaortic. Variations have been noticed in renal veins' origin, course and termination. The left renal vein passing behind the abdominal aorta is called "the retro



aortic left renal vein". Left renal vein anomalies are generally categorized into four types. In type I, the ventral preaortic limb of the left renal vein is obliterated, but the dorsal retro aortic limb persists and drains into the IVC in the orthotopic position. Type II results from the obliteration of the ventral preaortic limb of the left renal vein, while the dorsal limb turns into the Retroaortic left renal vein (RLRV), which joins the inferior venacava at L4-L5 level. 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, while dorsal limb courses obliquely and caudally into the left common iliac vein.<sup>[2][3]</sup>

The Knowledge of retro aortic left renal vein is of surgical importance when a left renal surgery is considered. Failure to recognize these anomalies may lead to severe haemorrhage and severe renal damage.<sup>[4][5]</sup> Previous studies have noted the overall prevalence of retro aortic left renal vein to be 3%.<sup>[6]</sup> In the present study we studied the course of left renal vein in 60 embalmed cadavers and 100 abdominal CT scan reports of patients showing urological symptoms. The results were statistically analysed.

## MATERIALS AND METHODS

We dissected 60 embalmed cadavers over the last three years to check for left renal vein anomalies. There were 55 male cadavers and 5 female cadavers, they all belonged to the age group between 18 and 70. Following the dissection, the left renal veins were identified and traced from the hilum of the left kidney to its termination. We also collected 100 abdominal CT scan reports of patients who showed urological symptoms and the course of the left renal vein was observed. The study was conducted in Department of Anatomy and Department of Radiology of Adichunchanagiri institute of medical sciences.

## RESULTS

In the present study, out of the 60 cadavers 2 cadavers showed retro aortic left renal vein. (3.3%)

In 58 cadavers, the left renal vein followed the normal course, where it traversed in front of the aorta and drained into the inferior vena cava in an orthotopic position.

Out of the two cadavers showing RLRV, in one cadaver, the anomaly was found to be type 2 retro aortic left renal vein, where the left renal vein arising from the hilum of

the left kidney passed obliquely downwards and drained into the inferior vena cava at the level of bifurcation of the aorta. Here the left renal vein measured 7 centimeters in length.

In another cadaver, there was a rare anomaly not reported till date, where the left renal vein coursed obliquely downwards and caudally behind the aorta and divided into two branches, upper branch draining into the inferior vena cava 3 cm above the bifurcation of the abdominal aorta and the lower branch drained at the junction of inferior vena cava and left common iliac vein. This variation hasn't been reported in any of the previous studies of the renal vein anomalies.

Along with the cadaveric study, we collected 100 abdominal CT scan reports of patients showing urological symptoms from the department of radiology and found that there were two cases of type 1 retro aortic left renal vein. When we went through the case history, we found that the patients had come to the surgery department with complaints of flank and abdomen pain, hematuria, and dysuria one of these patients had developed varicocele involving the left testicular vein which was later confirmed by investigations.



Figure 1: type 2 retro aortic left renal vein

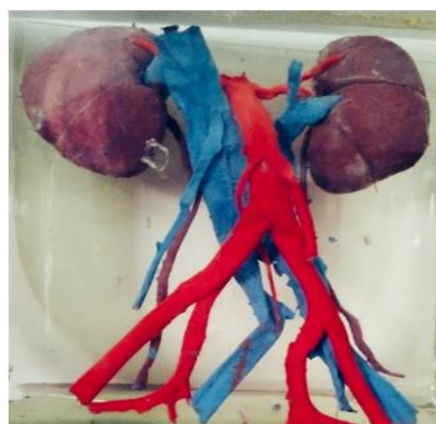
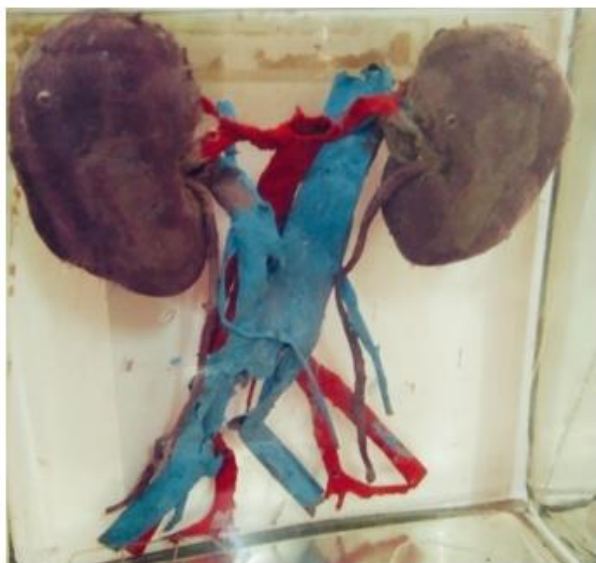


Figure 2: bifurcation of left renal vein -anterior view



**Figure 3: bifurcation of left renal vein - posterior view**



**Figure 4: type 1 retro aortic right renal vein**



**Figure 5: type 1 retro aortic right renal vein**

## DISCUSSION

The left renal vein anomalies are rare. The retro aortic left renal vein is reported with an incidence of less than 5%.

The portion of the vein lying in front of the aorta is developed from preaortic anastomosis between the right and left sub-cardinal veins. The part which receives the left suprarenal vein is derived from upper part of left sub cardinal vein. The portion of left renal vein receiving the left gonadal vein is developed from anastomosis between left supra cardinal and sub-cardinal veins. In Type II retro aortic left renal vein: The ventral preaortic limb of the left renal vein is obliterated and the remaining dorsal limb turns into the Retro aortic left renal vein. According to a study conducted by Cheng Lin Hsieh and his colleagues the incidence of retro aortic left renal vein is 0.5 to 3.6%, which is similar to the present study where we found an incidence of 3.3%. They reported 2 cases of type 3 retroaortic left renal vein 1 case of type 1 retroaortic left renal vein during a contrast CT examination of patients with urological symptoms.<sup>[7]</sup>

A study was done by Dilli A, and his colleagues on the percentages of the left renal vein variations of 1204 patients. The percentages of the total variations were 5.2% of which retro aortic left renal vein (RLRV) was 3.1%, and circumaortic left renal vein was 2.1%, respectively.<sup>[8]</sup>

S.S. Hassan, E.A. El-Shaarawy, J.C. Johnson<sup>3</sup> *et al.*; examined 63 cadavers, variations were found in 7 cadavers. Double, triple and quadruple veins were found unilaterally draining the kidneys.<sup>[9]</sup>

Anupma Gupta, Raman Gupta, Rikki Singal studied 30 embalmed cadavers, out of the 30 cases 13 of them normal pattern of drainage of renal veins, whereas 17 cases showed variations. Four main anatomic variants of the renal veins namely the supernumerary veins, retro-aortic, circumaortic left renal vein & plexiform left renal vein were observed.<sup>[10]</sup>

Fidel Rampersad and his colleagues found a case of retroaortic left renal vein when they conducted an MDCT scan on a 55-year-old woman. Here the left renal vein coursed obliquely and posterior to abdominal aorta to drain into the left common iliac vein prior to the origin of inferior venacava.<sup>[11]</sup>

Kawai K, Tanaka T, and Watanabe T reported a case where there were two left renal veins: one retroaortically drained into the inferior vena cava, and the other drained into the left common iliac vein.<sup>[12]</sup>

Cameron St Hilaire *et al.*, studied a case of nutcracker syndrome, being the cause of pelvic venous congestion, secondary to Retroaortic left renal vein.<sup>[13]</sup>



Antony H Chau *et al.* reported novel surgical techniques with robotic assisted left renal vein transposition to treat a 19 years old woman with renal nutcracker syndrome.<sup>[14]</sup> B Karaman *et al.* conducted a study, where 1856 patients with urological symptoms underwent a ct abdomen. And it was found that RLRV was detected in 68 (3.6%) of the 1856 patients, with 26, 22, 17, and three of types I, II, III, and IV.<sup>[15]</sup>

Provenza cg *et al.* found a left sided circumaortic renal vein anomaly along with a renal vein and renal artery aneurisms in a 59-year-old man with a history of chronic smoking. The patient did not have any abdominal pain or other urological symptoms. As the patient was asymptomatic, a conservative approach was undertaken to monitor his venous aneurism.<sup>[16]</sup>

Our findings are similar with observations done by Hassanet.al. (2017) and Gupta et.al. (2012), who reported various anatomical patterns and their embryological implications. Understanding these patterns is vital for procedures such as renal transplantation and laparoscopic surgeries, where a proper anatomical knowledge can prevent intraoperative complications (Bowdino et.al.,2022).<sup>[9,10,17]</sup>

The present study provides a comprehensive examination of left renal vein variations through both cadaveric dissection and Radiological imaging. This study also provides a valuable insight to available anatomical knowledge.

## CONCLUSION

In the present study we found the incidence of type 1 RLRV cases to be just 2% during the evaluation of CT scan reports and 0.6 % of type 2 RLRV in cadaveric study. Which is lesser than the incidence mentioned in the previous studies. This study reinforces the importance of recognizing left renal vein variations in clinical and surgical contexts, by highlighting the prevalence and clinical significance of these anomalies, we contribute to the broader understanding necessary for improving surgical outcome and better patient care.

## REFERENCES

1. Susan Standring. Gray's anatomy: the anatomical basis of clinical practice.39<sup>th</sup> edn, Edinburgh: Elsevier Churchill Livingstone; 2005: 1276.
2. Jong Kil Nam, Sung Woo Park, Sang Don Lee, and Moon Kee Chung. "The Clinical Significance of a Retroaortic Left Renal Vein" 2010 April; 51(4): 276–280
3. Thomas TV. Surgical implications of retroaortic left renal vein. Arch Surg.1970; 100:738–740.
4. Kyung DS, Lee JH, Shin DY, Kim DK, Choi IJ. The double retro-aortic left renal vein. *Anat Cell Biol.* 2012;45(4):282-284. doi:10.5115/acb.2012.45.4.282
5. Koc Z, Uluhan S, Tokmak N, Oguzkurt L, Yildirim T. Double retroaortic left renal veins as a possible cause of pelvic congestion syndrome: imaging findings in two patients. *Br J Radiol.* 2006 Oct;79(946):e152-5. doi: 10.1259/bjr/24717606. PMID: 16980674.
6. Hostiuc S, Rusu MC, Negoii I, Dorobanțu B, Grigoriu M. Anatomical variants of renal veins: A meta-analysis of prevalence. *Sci Rep.* 2019 Jul 25;9(1):10802. doi: 10.1038/s41598-019-47280-8. PMID: 31346244; PMCID: PMC6658480.
7. Hsieh C-L, Tiao W-M, Chou Y-H, *et al.* . Retroaortic Left Renal Vein: Three Case Reports. *J Med Ultrasound* 2012;**20**:1158.[doi:10.1016/j.jmu.2012.04.002](https://doi.org/10.1016/j.jmu.2012.04.002)
8. Dilli A, Ayaz UY, Kaplanoglu H, Saltas H, Hekimoglu B. "Evaluation of the left renal vein variations and inferior vena cava variations by means of helical computed tomography." 2013 May-Jun;37(3):530-5. doi: 10.1016/j.clinimag.2012.09.012. Epub 2012 Oct 25.
9. Hassan SS, El-Shaarawy EA, Johnson JC, Youakim MF, Ettarh R. Incidence of variations in human cadaveric renal vessels. *Folia Morphol (Warsz).* 2017;76(3):394-407. doi: 10.5603/FM.a2017.0020. Epub 2017 Mar 10. PMID: 28281721.
10. Gupta, Amit & Gupta, R. & Singal, Rikki. (2012). Congenital variations of renal veins: Embryological Background and clinical implications. *Journal of Clinical and Diagnostic Research.* 5. 1140-1143.
11. Rampersad F, Chan A, Diljohn J Retroaortic left renal vein (RLRV) draining into the left common iliac vein: a rare variant and its clinical implication *BMJ Case Reports* CP 2019;12: e230004.
12. . Kawai K, Tanaka T, Watanabe T. A rare anomaly of left renal vein drainage into the left common iliac vein: A case report. *Int J Surg Case Rep.* 2016;20:4-6. doi: 10.1016/j.ijscr.2015.12.050. Epub 2016 Jan 7. PMID: 26773205; PMCID: PMC4818290.



13. . St Hilaire C, Paisley M, Greene J, Casey KM. Left renal vein transposition for posterior Nutcracker syndrome. *J Vasc Surg Cases Innov Tech.* 2021;7(2):243-246. Published 2021 Mar 13. doi:10.1016/j.jvscit.2021.02.016
14. Chau AH, Abdul-Muhsin H, Peng X, Davila VJ, Castle EP, Money SR. Robotic-assisted left renal vein transposition as a novel surgical technique for the treatment of renal nutcracker syndrome. *J Vasc Surg Cases Innov Tech.* 2018 Feb 13;4(1):31-34. doi: 10.1016/j.jvscit.2017.09.008. PMID: 29541696; PMCID: PMC5849791.
15. Karaman B, Koplay M, Ozturk E, Basekim CC, Ogul H, Mutlu H, Kizilkaya E, Kantarci M. Retroaortic left renal vein: multidetector computed tomography angiography findings and its clinical importance. *Acta Radiol.* 2007 Apr;48(3):355-60. doi: 10.1080/02841850701244755. PMID: 17453511
16. Provenza CG, Boutrous M, Amankwah KS. Incidental finding of circumaortic left renal vein aneurysm on imaging. *J Vasc Surg Cases Innov Tech.* 2022 Aug 28;8(4):711-714. doi: 10.1016/j.jvscit.2022.08.012. PMID: 36425252; PMCID: PMC9678773
17. Bowdino CS, Owens J, Shaw PM. Anatomy, Abdomen and Pelvis, Renal Veins. 2022 Jan 7. In: *StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2022 Jan–.* PMID: 30855882.