Original Article

Anatomical Pattern and Variations of Left Renal Vein

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ABSTRACT

Objective: Left renal vein is unique in its tributaries, course and drainage area. The complex embryological developmental pathway and genetic factors may render variability to anatomy of left renal vein. Most of the previous studies on left renal vein have been conducted in non Asian countries with very little contribution from Asia. So this study was designed to study normal and variable anatomical patterns of left renal vein in Pakistani people.

Study Design: Observational / cross sectional study.

Place and Duration of Study: This study was conducted in Forensic & Anatomy departments of King Edward, Fatima Jinnah, Allama Iqbal Medical College and Postgraduate Med. Institute Lahore from Feb. 2008 to Jan. 2009.

Materials and Methods: There were fifty male cadavers. Cadavers dissection was carried out. Left renal vein along with kidney was exposed. A small cut was given in inferior vena cava and a mixture of gelatin with Indian ink was injected. Left renal vein and its variants were outlined and studied.

Results: Normal preaortic vein was found in 84% of cases. Other patterns of left renal vein observed in this study were circumaortic (2%), retroaortic (2%), double (2%) and proximally double renal vein (10% of cases).

Conclusion: This first of its kind study from Pakistan which shows renal vein varints are not uncommon and have impotant implications from surgical and radiological perspective. It provides an anatomical reference for future research in the fields of surgery and radiology.

Key Words: Left renal vein, variant patterns, primary tributaries

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INTRODUCTION

The need to extensively study the variations in pattern of renal veins is highly desirable particularly in the fields of urology and renal surgery in order to ensure minimum surgical damage.[1]The complex embryological developmental pathway and genetic factors may render variability to anatomy of left renal vein (LRV) thereby stressing upon the need to fully understand the latent anatomic variations for retroperitoneal operations. Literature review indicates left renal vein to be unique in its branches and drainage area. It may not always be single rather it may present as double, additional renal vein (ARV) or any other variant pattern. Supernumery renal veins have been observed (0.8% and 3% of study cases).[2] Normally renal vein of either side is formed by convergence of three primary tributaries emerging from the hilum of kidney of respective side. The left renal vein joins inferior vena cava (IVC), passing anterior to abdominal aorta, promptly below renal artery at the level of L2 vertebra. Apart from its primary tributaries from left kidney, the it also receives the left suprarenal and gonadal veins.[3] Occasionally, it is joined by the left inferior phrenic and rarely by one of the left lumbar veins.[4]

The left renal vein divergent forms have been divided into five groups: circumaortic left renal vein; retroaortic left renal vein type I; retroaortic left renal vein type II; duplication of IVC; and transposition of IVC.[5]The presurgical detection of these anomalies by imaging techniques has been rare (reported as 0.8% in computerized tomography) which is significantly less than their possible incidence as indicated by autopsy findings.[6]Knowledge of anomalous patterns in renal, aortic and general surgeries is important to avoid severe damage to the venous drainage of the left kidney and because intractable hemorrhage may occur in patients with unforeseen venous anomalies.[7] Most of the previous studies have been conducted in non Asian countries with very little contribution from Asia. Whereas no research has been carried out on left renal vein and its variation in Pakistani population, this study is a pioneering piece of work from Pakistan.

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MATERIALS AND METHODS

The study was conducted on 50 embalmed cadavers over a period of one year. Inclusion criteria were: cadavers with well-preserved renal vessels, IVC and kidneys. While exclusion criteria included: Apparently

diseased kidneys, congenital anomalies of kidneys or absence of one kidney, small kidneys due to surgery. (e.g partial nephrectomy), renal tumor, injury to renal veins and inferior vena cava.

Cadavers were dissected by dissecting anterior abdominal wall. After removing other viscera IVC, left kidney and renal vein were exposed. IVC was ligated, well above and below the termination of renal vein. A small cut was given in IVC inferior to the lower pole of kidney. An injection medium consisting of a mixture of gelatin with Indian ink was injected into IVC which in turn filled renal veins. Left renal vein and its variants were outlined and studied.

Data Analysis: Categorical variables were described as percentages.

RESULTS

Patterns of left renal vein which were observed in this study are shown in table 1.

Table No.1: Different patterns of left renal vein

Pattern	Left renal vein (n=50)	
	no of cases	Percentage
Additional RV	-	-
Double RV	1	2%
Proximally Double RV	5	10%
Circumaortic Renal Collar	1	2%
Retro-aortic	1	2%
Normal	42	84%

Normal pattern was found in 84% of cases (Table 1). In this pattern number of primary tributaries forming left renal vein varied from two to seven. Most frequent number of tributaries was three which was found in 38% of cases, whereas two tributaries occurred in 24% and four in 22% of cases. Maximum number of tributaries observed was seven (2% of cases). In normal pattern primary tributaries usually emerged from mid hilum or its upper and lower parts on the anterior aspect. In 10% of cases a posterior primary tributary emerging from posterior aspect of renal hilum was present. In this case the other tributaries as usual emerged from anterior aspect of hilum and joined to form renal vein while the posterior tributary emerged from the posterior aspect of hilum, passed anteriorly above or behind the renal pelvis, then between the branches of renal artery to join the renal vein on its posterior aspect a little distal to its formation.

Double left renal veinwas observed in 2% of cases (Table 1). In this pattern two renal veins (anterior and posterior) of approximately equal diameter were present independently. The anterior or preaortic vein was similar to the normal renal vein and joined the IVC at the level of L2. Suprarenal and testicular veins joined the anterior component. The posterior renal vein or retroaortic component formed by the union of three primary tributaries, emerged from the upper part of hilum of left kidney. It joined IVC below the anterior component at the level of L3 (Fig. 1). During its retroaortic course it also communicated with left ascending lumbar vein.

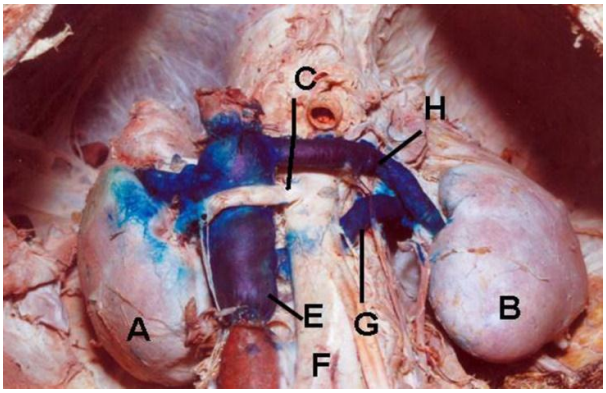

Figure No. 1: Anterior view of double LRV having an anterior component (H) and a posterior component (G) aorta (F), IVC (E), left kidney (B).

Proximally double left renal vein occurred in 10% of cases. In most cases two renal veins emerged from anterior aspect of mid hilum. The veins were parallel and each formed by union of two tributaries. The two veins later converged to form a single renal vein that joined IVC at the normal position (Fig. 2). Suprarenal and testicular veins joined single vein in most cases.

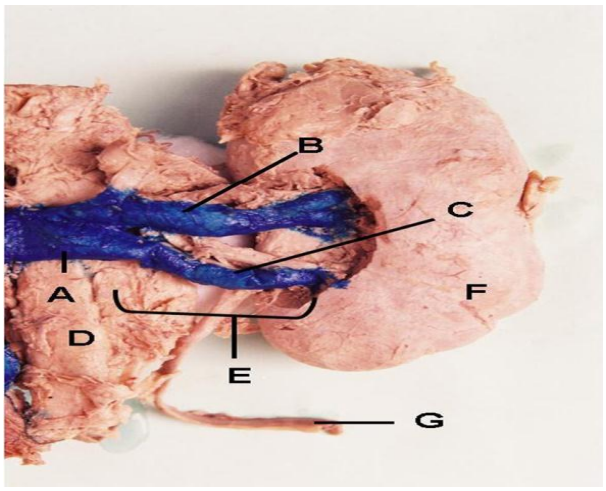

Figure No.2: Anterior aspect of left kidney (F) shows proximally double renal vein (E). Upper and lower (B, C) single renal vein (A).

Retroaortic left renal vein occurred in 2% of cases (Table 1, Fig. 3). In this case a renal vein formed by three primary tributaries originated from anterior aspect of the hilum of left kidney. At the renal hilum, two branches of renal artery passed in front of it while other branches passed behind it. It passed posterior to aorta to join IVC at the level of L3. There was no vein at normal position of left renal vein.

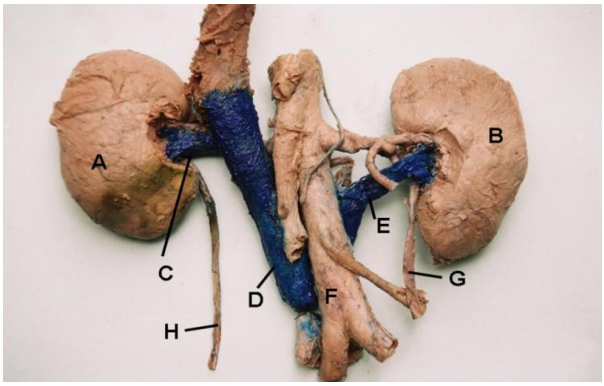

Figure No.3: Anterior view of both kidneys (A, B) showing left renal vein (E) passing retroaortically IVC (D); aorta (F).

Circumaortic renal vein was observed in 2% of cases. The anterior renal vein formed by the union of two primary tributaries originated from the anterior aspect of hilum of the kidney. It crossed medially in front of aorta and joined IVC at the level of L2. It also received the suprarenal and the testicular veins. The posterior renal vein originated from the posterior aspect of hilum by the union of two primary tributaries. It first passed medially and crossed behind the abdominal aorta, to join IVC at the level of L5 just above the bifurcation of IVC (Fig. 4). There was a small vein communicating the two veins at their commencement completing the collar around aorta.

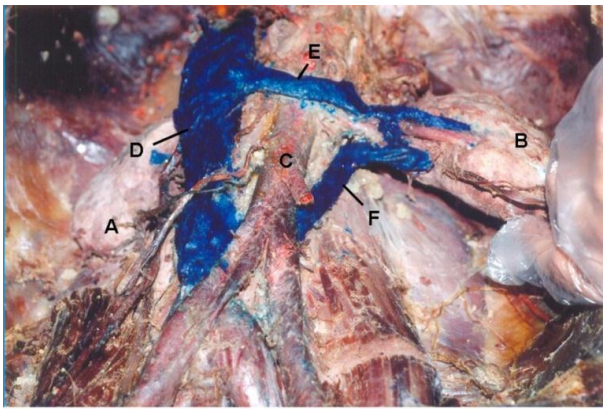

Figure No.4: Anterior view of circumaortic renal collar having an anterior component (E) and a posterior component (F). left kidney; C, aorta; D, IVC.

In the present study all normal and variable left renal veins terminated in IVC and no case was seen to terminate in veins other than IVC.

DISCUSSION

Pattern of normal left renal vein and its anomalous variants have been the focus of this study. Recent literature has asserted the significance of knowing the normal as well as its variant patterns for anatomical research as well as for surgical purposes.

The various patterns of left renal vein which were found in this study included preaortic, retroaortic and circumaortic veins. Normal pattern was found in 84% of cases similar to previous studies.[8]In this pattern number of primary tributaries forming left renal vein at renal hilum varied from two to seven. No additional renal vein (ARV) was found on the left side which is in accordance with findings of Dhar et al[1] who also could not find an ARV on left side. However in studies by Janschek et al[2]frequency of occurrence of left ARV was 6.7%. Most researchers did not differentiate between ARV and double renal vein while reporting multiple renal veins. Less occurrence of ARV on left side is due to complicated embryological development of left renal vein and its passageto reach IVC which would discourage the retention of additional veins.

Double left renal vein, one part preaortic and other retroaortic part was found in 2% of cases in our study.Studies have reported double left renal vein having one component being retroaortic in 6.5% of cases.[9] None of previous studies found both the veins passing anterior to aorta. Persistence of both the dorsal and ventral portions of circumaortic venous plexus during development results in this type of variant pattern in adults. Nayak[10]also reported double right renal vein in his study where two veins of equal size were found and testicular vein joined the inferior vein instead of IVC.

Proximally double left renal vein has been observed in 10% of cases in this study.In this pattern renal vein was double in its proximal half and single in distal half.The mean length of single part of proximally double renal veins was much less than normal renal vein.Although this variant pattern has been reported by some authors, it has not been described by most of the previous studies. Satheesha[11], Biswas et al[12] and Verma et al[13] also reported cases of proximal duplication of left renal vein. Senecail etal[14] reported cases of partial distal duplication of left retroaortic renal vein. In these cases renal vein emerged as a single vein from hilum but divided in distal half into two or more veins. Such duplication was not observed in present study. This variant pattern may present a real trap in abdominal imaging.

In our study circumaortic renal vein was found in 2% of cases. In an extensive study Satyapal et al[3]found circumaortic renal vein in 0.3% of cases. They mentioned that the incidence of renal collar varied widely in literature, with a range of 0.2% - 30%. Trigaux et al[15] reported circumaortic renal vein in 6.3% of cases where the testicular vein was connected to both the anterior and posterior components. While in the present study suprarenal and testicular veins joined the anterior component. Multiple renal veins and circumaortic renal collar are not only susceptible to avulsion injuries but also provide collateral channel if main renal vein is blocked or damaged. Clinically

recognition of this pattern is important because circumaortic renal collar may lead to unexpected venous heamorrhage where surgeon may not suspect a posterior component after having identified a normal LRV.[16,17]

Variant pattern of retroaortic left renal vein (RLRV) was also observed in this study (2% of cases). Satyapal et al[3]in an extensive study in South African population reported the incidence of RLRV as 0.5%. According to Karkos et al[18] the incidence of this anomaly as reported by anatomists in the literature ranges from 1.85-4.0%, while the reported incidence in radiological and surgical studies is 0.8%-3.7%. Yoshinaga et al[19] reported a very low incidence of 0.49% in Japanese population and therefore suggested that the low percentage may be due to racial differences. In their study retroaortic vein was connected directly to azygos and lumbar veins and received posterior suprarenal vein. Complications of retroaortic renal vein include hematuria, thrombotic pain, left renal vein hypertention and varicocele.[11]Pressure from RLRV may cause congestion of left kidney which if untreated may lead to chronic interstitial nephritis. Retrograde flow due to RLRV results in reflux in the gonadal veins which leads to pelvic congestion syndrome in females and nutcrackers syndrome in males.[14]

Any variation in termination of left renal vein was also noted. In the present study none of left renal vein variants joined any vein other than IVC. In our study a retroaortic LRV and posterior component of circumaortic LRV also joined IVC just above its formation at the level of L5. A case of RLRV joining the left common iliac vein instead of IVC was reported by Brancatelli et al.[20]

Our study confirms the findings of other recent studies that the variations in the venous pattern are encountered more often than reported earlier in the literature. The difference in the incidence of various variant patterns in different studies as well as in this study may presumably be due to racial differences. The presence or absence of various venous variations can influence both the management and outcome of surgical procedures which involve renal veins. Also modern-day innovative imaging techniques require a sound understanding of renal venous anatomy.[21,22] Appreciation of the most common anatomical variants, a high index of suspicion, careful reading of preoperative CT-Scan and safe operative technique are all vital if fatal complications are to be avoided.

CONCLUSION

The present study describes occurrence and anatomical features of various variations of left renal vein and their clinical implications in detail.This is an important baseline study from Pakistan which expands and augments the previous work. The findings of this study not only have implications but also provide an anatomical reference for future research in the fields of surgery and radiology.

Author's Contribution:

Concept & Design of Study:	Robina Shaheen
Drafting:	Robina Shaheen
Data Analysis:	Nasir Jamil
Revisiting Critically:	Robina Shaheen
Final Approval of version:	Robina Shaheen, Muhammad Nasir Jamil

Conflict of Interest: The study has no conflict of interest to declare by any author.

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