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Original Article

Anatomy Section

Morphometric Analysis of Renal Veins: A Cadaveric Cross-sectional Study

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ABSTRACT

Introduction: Each kidney is typically drained by a single renal vein, though variations exist. Sometimes, more than one renal vein may drain the kidneys, which is clinically significant as they often play a significant role in surgeries related to the kidneys.

Aim: To measure the morphological parameters of renal veins, as well as additional renal veins if present.

Materials and Methods: A cross-sectional study was conducted in the Department of Anatomy, Assam Medical College and Hospital, Dibrugarh, Assam, India from October 2021 to October 2024. A total number of 52 formalin-fixed human cadavers of both sexes were dissected, which included both adults (n=17) and perinatal cadavers (n=35). The parameters were the length and diameter of the renal veins and, if present, those of accessory renal veins. The length of the renal veins was measured with a measuring scale. The diameter of the renal veins was measured by using Vernier's calliper. Continuous variables were reported as Mean±Standard Deviation (SD). The categorical findings were expressed in percentages.

Results: Of the 52 cadavers studied, 37 (71.2%) were males, 15 (28.8%) were females. The study included 104 renal veins. The length of the adult Right Renal Vein (RRV) and Left Renal Vein (LRV) was 2.46±0.41 cm and 7.06±0.51 cm. In the case of a perinatal cadaver, the length of the right and LRVs was 1.21±0.3 cm and 1.86±0.5 cm, respectively. Of the 52, 3 (5.8%), showed the presence of accessory renal veins. Accessory renal vein on the left-side was present in 2 (3.8%) cadavers, whereas 1 (1.9%) cadaver showed it on the right-side.

Conclusion: The variations and course of renal veins help in nephrectomy and renal transplantation surgeries.

Keywords: Accessory renal vein, Cadaver, Nephrectomy, Renal transplantation

INTRODUCTION

The kidneys are a pair of excretory retroperitoneal organs, with a single renal vein on each side that drains into the Inferior Vena Cava (IVC). The LRV is approximately three times longer than the right, i.e., 7.5 cm and 2.5 cm, respectively [1]. Therefore, the left kidney is the preferred side for any operative procedure because of its long course. The LRV may vary and, in most instances, be duplicated, with each vessel encircling the aorta and finally draining into the IVC, forming the 'renal collar'. Sometimes LRV passes posterior to the aorta, then its called retro-aortic renal vein which may also result from persistence of posterior renal vein. The LRV is a very important structure that may affect procedures involving the aorta, e.g., ligation of the aorta during aortic aneurysm repair, as it lies close to the abdominal aorta [1]. There is always a more frequent presence of an additional or accessory renal vein on the right-side (7-38%) than on the left (1-3%) [2-6]. The LRV may also show either an intra- or extrarenal course at the hilum, suggesting an origin with double, triple, or multiple tributaries [7,8].

According to Satyapal KS, a renal vein is formed by the convergence of a variable number of primary tributaries emerging from the hilum. Apart from these primary tributaries, other individual independent vessels that open directly or join to form a separate vessel, drain into the IVC, and are variations of renal veins. He named these extra vessels the additional renal vein and polar veins, which drain separately into a single pole. He explained three major patterns of renal venous drainage, which are Type 1a: presence of two primary tributaries only, Type 2a: presence of more than two tributaries, and Type 3: any previous pattern explained with an additional renal vein/veins [9]. The study aimed to document the length and diameter of renal veins and, if present, accessory renal veins during cadaveric dissection, and to provide a detailed description of the variations.

MATERIALS AND METHODS

A cross-sectional study was conducted in the Department of Anatomy, Assam Medical College and Hospital, Dibrugarh, Assam, India from October 2021 to October 2024. For the study, permission from the Institutional Ethics Committee (IEC) (No. AMC/EC/PG/13853, dated 10/10/2021) and also consent from parents was obtained.

Inclusion criteria: All the kidneys retrieved from the dissected cadavers were included in the study.

Exclusion criteria: Kidneys that were putrefied, injured, or macerated were excluded from the study.

Study Procedure

A total number of 52 formalin-fixed human cadavers of both sexes were dissected, which included both adults and perinatal cadavers. Perinatal cadavers were collected from the Department of Obstetrics and Gynaecology, Assam Medical College and Hospital, which were stillborn foetuses. The adult cadavers were dissected with the first year MBBS students following Cunningham's Manual of Practical Anatomy [10] and Grant's Dissector [11]. The abdominal cavity was opened in layers and kidneys were approached. The renal veins on both sides were followed from the hilum till the IVC, and the abdominal aorta was reached. Both the kidneys, the abdominal aorta and the IVC were taken out as a single specimen. The parameters were measured after the specimen was thoroughly cleaned under tap water and tagged with a serial number. The parameters were the length and diameter of the renal veins and, if present, those of accessory renal veins. The length of the renal veins was measured with a measuring scale. The diameter of the renal veins was measured by using Vernier's calliper. The same steps were followed when accessory renal veins were observed. The diameter of the renal veins was measured at the point where it terminates into the IVC. The specimens were preserved in 10% formalin solution, and after one week, another set of readings was taken. The mean of

these two was taken as the final reading. The confluence of renal veins and the number of tributaries were also observed. When the renal veins are formed by union, it is termed renal confluence. Early confluence is when tributaries converge, and renal veins form just at the hilum, around 1 mm (at the renal sinus) [12].

STATISTICAL ANALYSIS

Continuous variables were reported as mean±standard deviation. The categorical findings were expressed in percentages.

RESULTS

Total number of cadavers was 52, among them 35 (67.3%) were perinates and 17 were (32.7%) adults. Of these 37 (71.2%) were males, 15 (28.8%) were females. The study includes 104 renal veins.

The length of the adult RRV and LRV was 2.46±0.41 cm and 7.06±0.51 cm. In the case of a perinatal cadaver, the length of the right and LRVs was 1.21±0.3 cm and 1.86±0.5 cm, respectively [Table/Fig-1].

	Length of Right Renal Vein (RRV) (cm)			Length of Left Renal Vein (LRV) (cm)			Diameter of Right Renal Vein (RRV) (cm)			Diameter of Left Renal Vein (LRV) (cm)		
	Maximum	Minimum	Mean±SD	Maximum	Minimum	Mean±SD	Maximum	Minimum	Mean±SD	Maximum	Minimum	Mean±SD
P	1.5	0.6	1.21±0.3	3.2	1.2	1.86±0.5	0.4	0.1	0.27±0.17	0.9	0.2	0.38±0.13
A	3	1.8	2.46±0.41	8	6	7.06±0.51	1.6	0.7	1.06±0.18	1.5	0.9	1.19±0.17

[Table/Fig-1]: Mean length and diameter of renal veins in both adult and perinatal cadavers.
P: Perinate; A: Adult; RRV: Right renal vein; LRV: Left renal vein; SD: Standard deviation

Of the 52, 3 (5.8%) showed the presence of accessory renal veins and all three were found in male cadavers. Accessory renal vein on the left-side was present in 2 (3.8%) cadavers, whereas 1 (1.9%) cadaver showed it on the right-side [Table/Fig-2]. Normal anatomical pattern of renal vessels on the anterior aspect is shown in [Table/Fig-3]. The left accessory renal vein was not circum-aortic in course; instead, it was located posterior to the main LRV that drained the upper pole and finally terminated in the LRV. The accessory RRV drains separately into the IVC [Table/Fig-4a,b].

	Total specimens	Specimens with ARV		Specimens with a normal pattern
		Right	Left	
P	70	0	1	69
A	34	1	1	32
Total	104	3 (2.9%)		101 (97.1%)

[Table/Fig-2]: Incidence and side distribution of Accessory Renal Veins (ARV).
P: Perinatal; A: Adult; ARV: Accessory renal vein

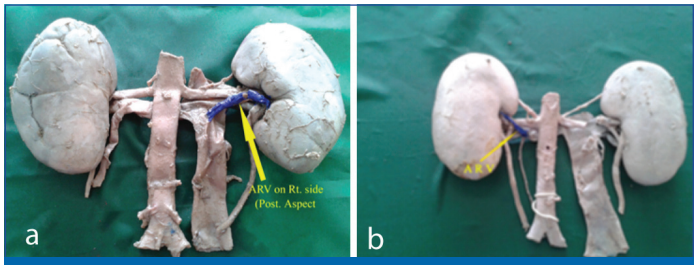
[Table/Fig-3]: Normal textbook pattern of renal vessels on anterior aspect. (IVC: Inferior vena cava; AA: Abdominal aorta; RRV: Right renal vein; LRV: Left renal vein; LRA: Left renal artery; RRA: Right renal artery)

The length and diameter of the accessory renal vein were 4 cm and 1.3 cm on the right-side and 3.5 cm and 1.2 cm on the left-side in both adult cadavers. In the case of the perinatal cadaver, the length of the accessory renal vein was 1.5 cm, and the diameter was 0.2 cm on the left-side.

Other findings of the present study included late confluence, observed in 4 (7.6%) cadavers; of these, 3 (5.8%) were on the left-side and 1 (1.9%) on the right-side. Early confluence was present in 6 (11.5%) cadavers, with right-sided early confluence in 4 (7.6%) and left-sided in 2 (3.9%) [Table/Fig-5a,b]. Polar veins draining the upper pole were present in 2 (3.8%) cadavers, each on the right and left-sides. From the inferior pole, 3 (5.8%) veins were present; all were on the right-side.

DISCUSSION

In the present study, accessory renal veins were observed in 5.8% (3 cadavers) out of 52 cadavers. Narayana AS et al., observed that among 40 cadavers, accessory renal vein was present in the right side in 1 (2.5%) cadaver [13]. Similarly, Nahar SP and Nahar PS, reported that additional renal veins were fewer on the left-side {3 (4%)} than on the right-side {10 (13.3%)} among 75 cadavers [14].



[Table/Fig-4]: a) Additional renal vein on the right-side (post view); b) (left-side) posterior view.

[Table/Fig-5]: Left: a) Late confluence on the left-side (posterior view); Right: b) Early confluence of LRV (anterior view).
AA: Abdominal aorta; IVC: Inferior vena cava

Srivastava A et al., reported that 29.8% of cases had accessory renal veins on the right-side, whereas only 1.1% were observed on the left-side [15]. Similarly, Gupta M et al., stated that accessory renal veins were found on the right-side (8.3%) in their study [16]. Gupta A et al., reported that among 30 cadavers, 36.3% exhibited supernumerary renal veins [17]. In a radiological study, Famurewa OC et al., analysed 200 abdominal CT scans and observed multiple renal veins in 2.5% of cases on both the right and left-sides [18]. Agarwal J et al., in a study conducted on 30 human cadavers of either sex, reported the presence of two accessory renal veins on the right-side in 3.33% of cadavers, with no variations observed on the left-side [19].

Very few studies have reported the morphometric parameters, such as the length and diameter of renal veins. In the present study, the average measurements were: RRV length, 2.46±0.41 cm; and LRV length, 7.06±0.51 cm. The diameter of the RRV and LRV was 1.06±0.18 cm and 1.19±0.17 cm, respectively. These findings were

comparable to the observations of Vaghela BP et al., who reported a mean RRV length of 20.76±2.6 mm and an LRV of 60.1±6.42 mm [20]. The average length of the LRV was 62.44 mm and that of the right-side was 26.98 mm, as observed in 50 cadavers, as stated by Kumari S et al., [21].

In another study, Srivastava A et al., reported the mean length of the right and LRV as 15.28±7.02 mm and 24.04±11.51 mm, respectively. The mean diameter of the RRV and LRVs was 10.39±2.63 mm and 10.9±3.99 mm, respectively [15].

Vedaraju KS et al., reported that late venous confluence into the IVC was the commonest venous variant, more on the left-side (14 out of 20) [22]. Srivastava A et al., also reported late confluence of the renal veins in 28.7% on the right-side and 12.6% on the left-side [15]. In a radiological study of 200 abdominal CT scans, Famurewa OC et al., observed late venous confluence in 3% of cases on the right and 2.5% on the left [18]. Variations in incidence may be attributed to differences in sample size, study population, and methodology.

Limitation(s)

The study was conducted at a single institution, which may limit the generalisability of the findings. Measurements obtained from embalmed cadavers may differ from in-vivo conditions due to tissue shrinkage, distortion, or loss of vascular tone. Manual measurement techniques may introduce observer or instrumental error, despite efforts to standardise procedures.

CONCLUSION(S)

Preoperative knowledge of renal vein variations is important during surgical planning. Unrecognised variations may lead to intraoperative complications due to their close relationship with the abdominal aorta and other major vessels. Therefore, proper identification and documentation of these variations are essential.

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