CASE REPORT

Coexistence of Dual Hila, Double Renal Arteries, and Incomplete Ureteric Duplication in a Single Kidney: A Cadaveric Case Report

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Abstract

Isolated variations in the renal vasculature and the collecting system are relatively common and well-studied, however their coexistence in a single kidney as a complex anatomical constellation is less documented and clinically significant. Such variations may complicate radiological interpretations, and increase the risk of iatrogenic injury. These anomalies are thought to have an embryological origin involving the renal ascent, persistence of transient embryonic vessels, and early bifurcation of the ureteric bud during development.

We report a case of a left kidney exhibiting dual renal hila with separate vascular pedicles and incomplete ureteric duplication in an adult Sri Lankan male cadaver. During routine dissections the left kidney was seen to have two distinct renal hila, each supplied by an independent renal artery arising from the abdominal aorta at different vertebral levels, with corresponding venous drainage converging into the left renal vein. Two renal pelves originated separately at each hilum and continued as duplicated ureters that fused to form a single ureter before entering the urinary bladder. The contralateral right kidney showed a single hilum with dual renal arteries. This combination of dual renal hila, multiple renal arteries and veins, and incomplete ureteric duplication within a single kidney is exceptionally rare and, to the author's knowledge, represents the first documented cadaveric case from Sri Lanka. Awareness of such complex renal anatomical variations is essential for surgeons and radiologists to avoid diagnostic errors and operative complications. Detailed documentation of these anomalies contributes to anatomical literature and enhances clinical safety.

Keywords: Renal anatomical variations; Dual renal hilum; Accessory renal arteries; Incomplete duplex ureter; Cadaveric study

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Introduction

The kidneys are retroperitoneal; directly related to the posterior abdominal wall. They lie in the extraperitoneal connective tissue immediately lateral to the vertebral column. Kidneys extended approximately from the twelfth thoracic vertebra (T12) superiorly to the third lumbar vertebra (L3) inferiorly, with the right kidney somewhat lower than the left, presumably because of its downward displacement by the liver (1, 2). They are similar in size and shape. On the medial aspect of each kidney lies the renal hilum, a deep vertical cleft through which the renal vessels and the renal pelvis enter and exit the kidney (1). Usually, a subsidiary branch of the renal artery, lymphatics and nerves also enter the hilum (2).

The renal artery, a lateral branch of the abdominal aorta, supplies each kidney. These arteries usually originate just inferior to the origin of the superior mesenteric artery between vertebrae L1 and L2. The left renal artery usually arises a little higher than the right, and the right renal artery is longer and passes posterior to the inferior vena cava (1, 3). It enters the renal hilum in relation to the renal vein anteriorly and the renal pelvis posteriorly. At or near the hilum, the renal artery divides into anterior and posterior divisions. Each division gives rise to segmental arteries within the renal sinus, which supply specific segments of renal tissue. Thus, the segmental arteries are essentially end arteries (3). Accidental damage or ligation during surgical procedures will result in infarction of the segment supplied by it (4).

Accessory renal arteries are common. They originate from the lateral aspect of the abdominal aorta, either above or below the primary renal arteries, enter the hilum with the primary arteries or pass directly into the kidney at some other level, and are commonly called extrahilar arteries (1). They have been observed in approximately 30% of individuals (5).

Multiple renal veins contribute to the formation of the left and right renal veins, both of which are anterior to the renal arteries drain to inferior vena cava. The ureters are muscular tubes that transport urine from the kidneys to the bladder. They are continuous superiorly with the renal pelvis, which is a funnel-shaped structure in the renal sinus (1). The renal pelvis is subject to considerable anatomical variations. It may lie completely outside the substance of the kidney or may be almost buried in the renal hilum. The ureter comprises its abdominal, pelvic and intravesical portions.

The kidney first develops in the pelvis and then migrates upwards. Its blood supply is first obtained from the common iliac artery. During migration, a series of vessels form to supply it, only to involute again when the renal artery takes over this duty. It is common for one or more distally placed arteries to persist (aberrant renal arteries), and one may even run to the kidney from the common iliac artery.

The mesonephric duct may give off a double metanephric bud so that two ureters may develop on one or both sides. These ureters may fuse into a single duct anywhere along their course or open separately into the bladder.

In the venous system, variations in the drainage pattern that diverge from the classically described paired vessels flowing into the inferior vena cava (IVC) have been well documented and can have an incidence rate similar to that of the arterial system (5).

These individual variations in the arterial, venous, and ureteral patterning of the kidneys are not rare and well-studied, but concomitant involvement of variant anatomy in these systems appears to be rarer. It's important to discover these incidences as they are useful clinically. Awareness of such complex anatomical patterns is essential for radiologists, urologists, and transplant surgeons to prevent diagnostic errors and intraoperative complications. Detailed

documentation of these variants contributes meaningfully to anatomical scholarship and surgical safety, and also ensures optimal outcomes.

Case report

The standard routine abdominal dissection was done in a formalin-fixed cadaver of a 60–70-year-old male in the Department of Anatomy, Faculty of Medicine, Sabaragamuwa University of Sri Lanka. Following the anterior abdominal wall dissection, retroperitoneal dissection was performed, and the bilateral kidneys, renal vascular pedicles, and ureters were exposed. Renal arteries and veins were traced up to their aortic and caval origins. The vertebral levels were exposed to demonstrate the kidney span, hilar level, and vascular origins. They were recorded relative to fixed landmarks. The order of hilar structures was noted at each hilum.

No surgical scars were observed on the abdomen during inspection before dissection. No evidence of renal surgery was observed.

The left kidney had dual hila with separate renal arteries and veins. Also, there were two separate ureters, and each raised at each hilum. Upper renal artery arises at the level of L2 where just below the origin of superior mesenteric artery (Figure 2 and 3). The lower renal artery originated just below the origin of the inferior mesenteric artery and was smaller in diameter than the upper renal artery (Figure 2 and 3). Both upper and lower veins accompanied the corresponding arteries and drained to the inferior vena cava through the left renal vein (Figure 3). The collecting system was assessed for duplication; both originating at each hilum and made a confluence (Figure 3). The ureter followed its usual anatomical pathway to connect with the bladder.

Regarding the right kidney, there was one hilum, although the presence of dual renal arteries was noted (Figure 4). The upper renal artery originated just below the origin of the superior mesenteric artery. An accessory renal artery was seen to arise just above the origin of the inferior mesenteric artery (Figure 1).

Findings were photographed, and schematic representations were made for comparison with established anatomical descriptions.

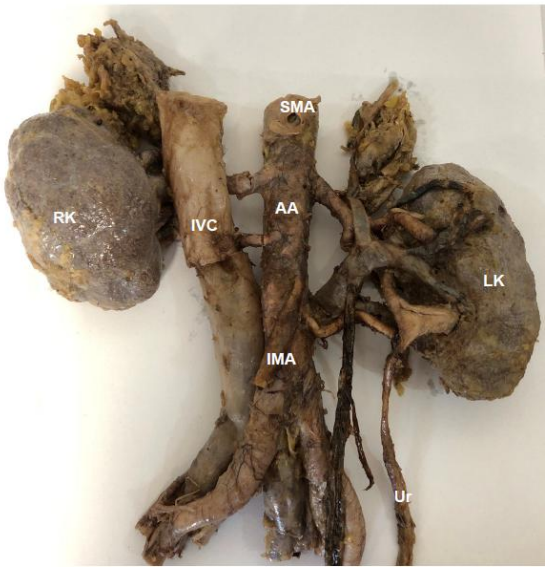

Figure 1: Dissected left & right kidneys RK- Right Kidney; LK- Left Kidney; IVC- Inferior Vena Cava; AA- Abdominal Aorta; SMA- Superior Mesenteric Artery; IMA- Inferior Mesenteric Artery; Ur- Left Ureter

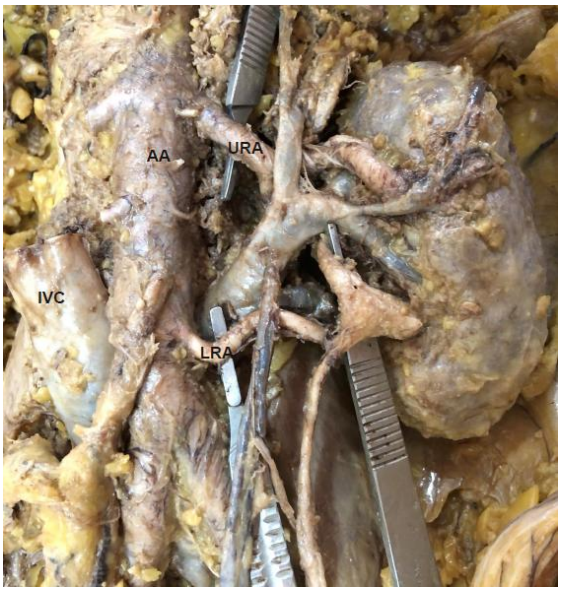

Figure 2: Anterior view of the Left Kidney. AA- Abdominal Aorta; IVC- Inferior Vena Cava; RV- Renal Vein; URA- Upper Renal Artery; LRA- Lower Renal Artery

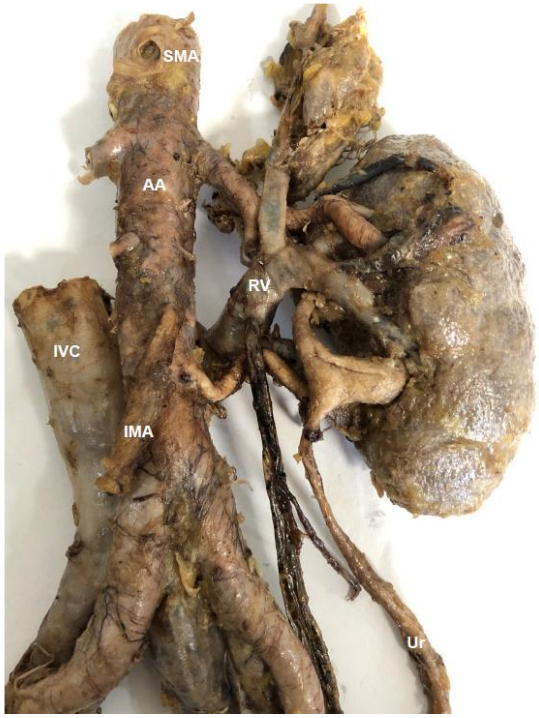

Figure 3: Anterior view of the Left Kidney. AA- Abdominal Aorta; IVC- Inferior Vena Cava; RV- Renal Vein; SMA- Superior Mesenteric Artery; IMA- Inferior Mesenteric Artery; Ur- Ureter

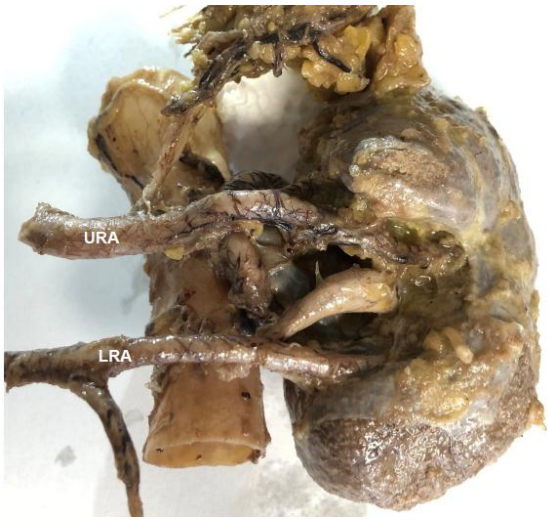

Figure 4: Posterior view of the Right Kidney (URA – Upper Renal Artery; LRA- Lower Renal Artery)

Discussion

The variations of renal vasculature or collecting systems are individually well recognized and studied; their coexistence in this precise configuration is less studied. This case report illustrates that exceptionally rare concurrence of renal anatomical variations; dual renal hila, separate vascular pedicles, and incomplete ureteric duplication within a single kidney, accompanied by contralateral arterial multiplicity.

This variation is explained by the embryological development failures as follows. Renal development is a coordinated process, three slightly overlapping kidney systems are formed in a cranial to caudal sequence: the pronephros, mesonephros, and metanephros. The first of these systems is rudimentary and nonfunctional, the second may function for a short time during the early fetal period and the third forms the permanent kidney. The third urinary organ, the metanephros or permanent kidney, appears in the fifth week of gestation. Collecting ducts of the permanent kidney develop from the ureteric bud, which is an outgrowth of the mesonephric duct. The ureteric bud gives rise to the ureter, the renal pelvis, the major and minor calyces and tubules. However, as a developmental failure, the duplication of the ureter results from early splitting of the ureteric bud. Splitting may be partial or complete, and metanephric tissue may be divided into two parts, each with its own renal pelvis and ureter (1, 6). Partial duplication of the ureter results from early bifurcation of the ureteric bud, with incomplete fusion resulting in proximal duplication and distal convergence. This duplex kidney anatomical variation is two times more commonly observed in females than in men, but the cause is still unclear. There have been reports that unilateral duplication is six times more common than bilateral duplication (7).

The kidney first develops in the pelvis and then migrates upwards up to the lumbar region. Its blood supply is first obtained from the common iliac artery. During migration, a successive formation and regression of transient vessels form to supply it along the

pathway, only to involute again when the renal artery takes over this duty. It is common for one or more distally placed vessels to persist (aberrant/ accessory renal vessels), and one may even run to the kidney from the common iliac vessels (1, 6). The formation of dual renal hila in this left kidney indicates a failure of regression of segmental vessels and collecting system components, which prevents the formation of a single hilum for the kidney.

The right kidney exhibits common individual anatomical variations, obtaining its blood supply from both the renal artery and the accessory renal artery. Otherwise, the right hilum represents the usual anatomy of the kidney.

The arteries branching give segmental arteries, and they are end arteries for their specific segments (3). The vesicoureteral reflux is the most common abnormality associated with the duplex collecting system (8). Vesicoureteral reflux is most closely associated with incomplete duplication, with an incidence of 22% (8). Awareness and documentation of such variants are essential to enhance diagnostic accuracy, guide surgical strategy, and ultimately improve patient safety. As this is the first documented case report with complex variations, it will expand the documented spectrum of renal variation and improve the research area of the anatomy literature.

Conclusion

This case represents cadaveric urinary and vascular anomalies observed in a male cadaver. This is the first documented cadaveric case report according to our knowledge; describing dual renal arteries at two levels, bifid venous drainage via two hila and incomplete ureteric duplication of the ureter in the left kidney. These variants give major implications for imaging interpretation and surgical procedures. This case report will shed light on further studies in embryology, clinical and anatomical fields.

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Authors' contributions

K.A.N.I. Kodikara, P.G.M.U. Gunasekara, C.H. Balasooriya, D.M.S.K. Dharmathilaka wrote the first draft of the manuscript. Y.D. Kolambage and T.C.S. Weerakoon designed and conceptualized the study. P.G.M.U. Gunasekara, C.H. Balasooriya, D.M.S.K. Dharmathilaka prepared and labelled the figures. All authors read and approved the case report before submission.

Conflict of interest

The authors declare that there are no conflicts of interest associated with this manuscript.

Data Availability

All relevant data related to this study are included within the manuscript. No additional data sets were generated or analyzed during the study.

References

1. Drake RL, Vogl AWM, Mitchell AWM. Gray's anatomy for students. 5th Edition. Elsevier; 2023.
2. Ellis H, Mahadevan V. Clinical anatomy: Applied anatomy for students and junior doctors. 14th Edition. Wiley-Blackwell; 2018.
3. Pradhay G, Gopidas GS, Karumathil Pullara S, Mathew G, Mathew AJ, Sukumaran TT, et al. Prevalence and Relevance of Multiple Renal Arteries: A Radioanatomical Perspective. Cureus. 2021 Oct 21. https://doi.org/10.7759/cureus.18957
4. Salimy MS, Luiselli GA, Yuen M, Healy RC, Shah SG, Giannaris EL, et al. A case of solitary kidney with duplex collecting systems and renal vascular variants in an

adult male cadaver. Folia Morphol. 2021;80(3):722–5. https://doi.org/10.5603/FM.a2020.0082 PubMed PMID: 32748948

5. Dunnwald M, Pizzimenti MA. A Case Study of Malrotated Kidneys with Asymmetric Multiple Renal Arteries, Variant Venous Drainage, and Unilateral Ureteral Duplication. Case Rep Vasc Med. 2019 Mar 18; 2019: 1–7. https://doi.org/10.1155/2019/1893137
6. Sadler TW. Langman's Medical Embryology. 14th Edition. Wolters Kluwer; 2024.
7. Siomou E, Papadopoulou F, Kollios KD, Photopoulos A, Evagelidou E, Androulakakis P, et al. Duplex collecting system diagnosed during the first 6 years of life after a first urinary tract infection: a study of 63 children. J Urol. 2006 Feb;175(2):678–82. https://doi.org/10.1016/S0022-5347(05)00184-9 PubMed PMID: 16407023.
8. Bisset GS, Strife JL. The duplex collecting system in girls with urinary tract infection: prevalence and significance. AJR Am J Roentgenol. 1987 Mar;148(3):497–500. https://doi.org/10.2214/ajr.148.3.497 PubMed PMID: 3492875.