Journal of
Anatomy and Physiological Studies

CASE REPORT

Accessory Renal Arteries: Origins and Clinical Implications

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Abstract

Routine academic dissection of an embalmed 82-year-old female cadaver revealed a unilateral variant in the vascular anatomy, specifically an inferior accessory renal artery located on the right side. This anatomical variation is the least common of all identified renovascular variants and has little previous documentation in existing literature. This case report describes the findings in detail, outlines the embryological origins, and examines the precedence in literature. The inferior polar accessory renal artery has been implicated in cases of uncontrolled hypertension secondary to overstimulation of the renin-angiotensin system and surgical complications associated with vessel occlusion and subsequent ischemia of the kidney. Anatomic variations similar to the one discussed in this case report should be considered to prevent adverse outcomes in both the clinic and operating room.

Keywords: Kidney, Nephrology, Anatomical variant, Renal artery, Cadaver dissection, Renal anatomy, Hypertension, Renal embryology

Introduction

The kidneys are paired retroperitoneal organs that receive 20-25% of cardiac output and function in the filtration of blood and maintenance of fluid homeostasis. In the majority of the population, each kidney is perfused by a single renal artery that branches from the abdominal aorta at the level of the L1-2 vertebrae and enters the renal hilum. However, the presence of a single hilar renal artery has been shown to vary profoundly in different studies, with prevalence ranging from 63-97%. In the remainder of these cases, the blood supply to the kidney includes accessory or aberrant renal arteries. Accessory renal arteries are auxiliary to the main renal artery and generally travel together with the renal artery through the hilum into the kidney. On the other hand, aberrant renal arteries are the sole source of kidney perfusion and typically branch directly from the abdominal aorta, entering the kidney outside of the hilum [1].

A recent comprehensive study examining 530 adult cadavers identified that approximately 25% of the specimens had accessory renal arteries [2]. An additional study comparing 30 cadaveric and 583 radiology CT samples found the variant identified in this case study, a unilateral inferior polar accessory renal artery, to be the least common abnormality, present in only 3.48% of cadaveric and 1.2% of radiologic samples [3]. The renal artery variant identified in this case study is one of several renovascular abnormalities that may present additional concerns for procedural and surgical interventions on the kidney. Therefore, it is vital that these renovascular variants be identified prior to any procedural or surgical interventions to avoid renal ischemia and other related complications including end organ damage (Table 1).

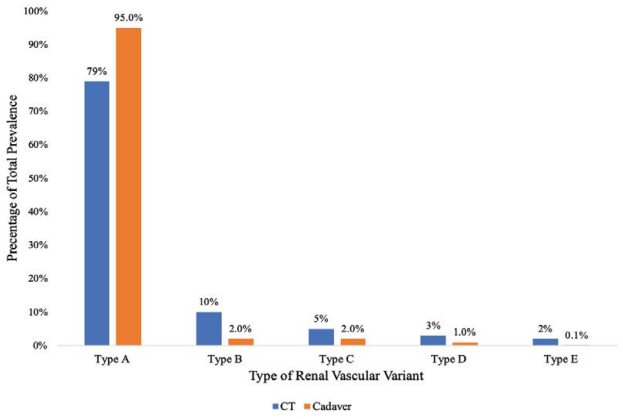

Table 1: This table outlines different studies that have identified the prevalence of renovascular variants. Type A, aortic hilar artery, incidences were 79% in cadavers and 95% in CT. Type B, hilar upper polar artery, incidences were 10% in cadavers and 2% in CT. Type C, aortic upper polar artery, incidences were 5% in cadavers and 2% in CT. Type D, aortic lower polar artery, incidences were 3% in cadavers and 1% in CT. Type E, hilar lower polar artery, incidences were 2% in cadaver and less than 0.1% in CT (as seen in this case study.) The pattern represents the number of arteries perfusing one kidney.[3] This table was adapted from *Anatomical variations of the renal arteries: Cadaveric and radiologic study, review of the literature, and proposal of a new classification of clinical interest* by Clara Cases et al.

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Received: Dec 04, 2019; **Accepted:** Dec 11, 2019; **Published:** Dec 16, 2019

*This article is reviewed by "Chakravarthy Marx Sadacharan, USA"

Case Information

During routine academic dissection of an embalmed 82-year-old female cadaver, a unilateral accessory renal artery was identified on the right side. Furthermore, the primary renal artery branched prematurely into its respective segmental arteries as they entered the right kidney. The accessory renal artery branched directly from the anterolateral aspect of the abdominal aorta approximately 2-3 cm prior to its bifurcation, passing inferior to the ureter and gonadal veins as it entered the inferior pole of the right kidney. Upon dissection, metastases due to small cell lung cancer were identified throughout the organ systems, including a mass that occluded the hilum of the left kidney, likely leading to the observed hydronephrosis. There were also masses present on the right kidney that involved the ureter and posterolateral aspect of the right kidney (Figure 1&2).

Discussion

The presence of an accessory renal artery, along with the other renovascular variants, can be traced back to the development of the adult kidney and its respective arteries during the early stages of embryogenesis. More specifically, in the third week of embryogenesis, the trilaminar disc consisting of ectoderm, mesoderm, and endoderm has formed. From this, the intermediate mesoderm gives rise to the urinary ridge, which later differentiates into the pronephros, mesonephros, and metanephros. It is important to note that both the mesonephros and metanephros are functional kidneys; however, it is the latter that develops into the adult kidney and is functional by the tenth week of development. The adult kidneys will first develop in the pelvic region and undergo a rostral migration from weeks six to nine, until contact is made with the upper border – the adrenal glands, which are located in the abdominal cavity. During this ascension, the perfusion of the kidneys is maintained by the formation and degradation of transient renal arteries from the abdominal aorta. It is the persistence of more than one of these arteries that ultimately gives rise to supernumerary arteries, as observed in this case study [4,5].

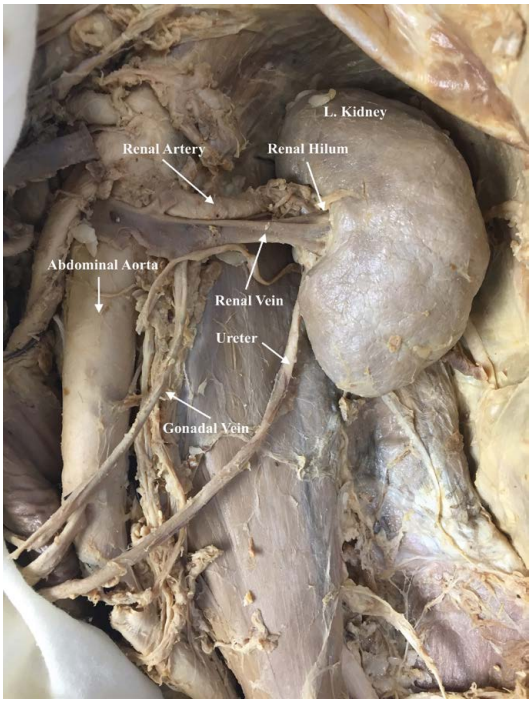

Figure 1: An image of a healthy left kidney with the presence of a single renal artery that branches off the abdominal aorta at the L1 spinal level prior to the aortic bifurcation, entering the renal hilum to the left kidney.

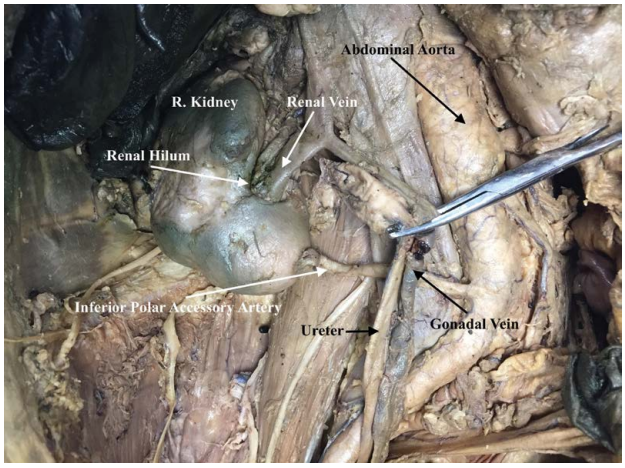

Figure 2: An image of the unilateral inferior polar accessory renal artery identified in an 82-year-old female cadaver. The accessory renal artery branches off the abdominal aorta at the L4 spinal level just prior to the aortic bifurcation, and travels posterior to both the ureter and gonadal vein as it enters the inferior pole of the right kidney. Additionally, the segmental branches of the primary renal artery enter the renal hilum.

Maintaining adequate perfusion to the kidneys is necessary for normal renal function; therefore, it is important to identify the presence of abnormal accessory and aberrant renal vasculature and the effects in both a clinical and surgical setting. Uncontrolled hypertension is a common finding in individuals identified to have an accessory renal artery due to the decreased perfusion pressure that results in increased stimulation of the renin-angiotensin system, which is ultimately responsible for increased blood pressure. Of interest, in a study by Kem et al., a 5-year-old boy with hypertension secondary to a single aberrant renal artery that entered the kidney at the inferior pole was identified. Furthermore, the renal vein renin in the absence of stimulation showed a 2:1 ratio respective to the right and left kidneys, proposed to be caused by the decreased blood flow to the right kidney. One month following treatment, the 5-year-old boy demonstrated appreciable improvement in blood pressure, which was 120/70 mmHg without medications in comparison to his previously documented blood pressure of 190/130 mmHg. In the surgical setting, the identification of aberrant and accessory renal vasculature is vital for preventing ischemia and preserving the kidney, especially in cases where the accessory artery is the sole source of blood supply. In surgical treatments of hydronephrosis, it is important to note the relative position of the aberrant artery to the ureter in order to prevent obstruction of

the artery [6]. In cases of renal transplantation, the presence of additional renal arteries has been suggested to be a potential factor in surgical complications [7,8]. In interventional radiological procedures as well as intra-abdominal laparoscopic surgery not related to the renal vasculature, identification of polar renal arteries is important for the success of procedures and avoidance of complications [9,10]. Identification and careful approach of accessory renal arteries also poses an important challenge for endovascular repair of thoracic and abdominal aortic aneurysms. Multiple retrospective studies have concluded that the presence of accessory renal arteries is also an important risk factor for renal dysfunction following endovascular aortic repair [11-13]. Mechanisms of renal dysfunction following these procedures involve occlusion of the renal artery, leading to higher incidence of renal infarct during and after the procedure [12]. In general, the early identification of aberrant or accessory vasculature can help prevent adverse outcomes, both in the operating room and the clinic.

Acknowledgement

The students and faculty of the University of North Texas Health Science Center would like to express their gratitude to the donors of our Willed Body Program. Their gifts have made countless research and education opportunities possible, and for this, we thank them.

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Citation: Russell Vo, Mirochnitchenko A, Kichena S, Lammers C, Fisher CL (2019) Accessory Renal Arteries: Origins and Clinical Implications. J Anat Physiol Stud 3: 001-003.

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