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Triple Renal Artery in a Dog: A Rare Anatomical Variation[1]

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* Reporte de caso.

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Abstract

Renal arteries have been anatomically studied, particularly emphasizing numerical variation across different animal species. The origins of renal arteries from the abdominal aorta vary according to renal topography in many species. The right renal artery originates more cranially than the left due to the cranial position of the right kidney. This report describes a case of a left triple renal artery arising from the lateral surface of the abdominal aorta in a male mongrel adult dog. During dissection, it was observed that three renal arteries supplied the left kidney with different topographies and arrangements. The right kidney was supplied by a single renal artery. Numerical variations in canine renal arteries must be considered in surgical and experimental procedures to avoid errors arising from unfamiliarity with these variations.

Keywords: Animal anatomy; kidney; triplicity; vascularization.

Arteria renal triple en un perro: una rara variación anatómica

Resumen

Las arterias renales se han estudiado anatómicamente, enfatizando particularmente la variación numérica entre diferentes especies animales. Los orígenes de las arterias renales de la aorta abdominal varían según la topografía renal en muchas especies. La arteria renal derecha se origina más cranealmente que la izquierda debido a la posición craneal del riñón derecho. Este artículo describe un caso de una arteria renal triple izquierda que surge de la superficie lateral de la aorta abdominal en un perro adulto mestizo macho. Durante la disección se observó que tres arterias renales irrigaban el riñón izquierdo con diferentes topografías y disposiciones. El riñón derecho estaba irrigado por una única arteria renal. Las variaciones numéricas en las arterias renales caninas deben considerarse en procedimientos quirúrgicos y experimentales para evitar errores derivados de la falta de familiaridad con estas variaciones.

Palabras clave: anatomía animal; riñón; triplicidad; vascularización.

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Introduction

Understanding anatomical variations of renal blood vessels is crucial for the clinical investigation of kidneys and surgical interventions such as renal transplantation, renal trauma treatment, renovascular hypertension, renal artery embolization, angioplasty, conservative or radical kidney surgery (1). Kidneys are paired retroperitoneal structures on the dorsal abdominal wall on either side of the vertebral column. While primarily located in the lumbar region, they extend cranially beneath the last ribs, intruding into the intrathoracic portion of the abdomen and responding to diaphragmatic movement (2). The right kidney is situated more cranially than the left and contacts the caudate process of the liver and the right hepatic lobe. Its location is delimited by a renal impression on the liver, while the more mobile left kidney lacks such an impression (2).

Each kidney is supplied by a renal artery, a branch of the abdominal aorta, accounting for about a tenth of cardiac output. The venous system, draining into the caudal vena cava, consists mainly of satellite veins (3). Identifying congenital anomalies of the renal pedicle in domestic animals is crucial for surgeons and radiologists, as these anomalies, while uncommon in veterinary medicine, require recognition before vascular procedures to avoid confusion between atypical and pathological appearances obtained through imaging diagnostics.

When investigating variations in human renal arteries, Sampaio and Passos (4) identified various configurations, including duplications or triplications and arterial branches supplying the kidney's upper and lower poles. They noted that the terminology used to describe these variations often lacks consistency, with terms like "extra," "aberrant," or "accessory" being inappropriate, as these segments correspond to additional segmental branches intended for renal supply. Therefore, they proposed the term "multiple renal arteries," emphasizing the practical importance of these structures. Furthermore, multiple renal arteries in humans add complexity to renal transplantation (5) and show a stronger correlation with renal pathologies than organs supplied by a single renal artery (4).

In studies on variations in canine renal arteries, cases of triple renal arteries are seldom documented. This article aims to report one case of a triple renal artery in a dog, emphasizing the importance of knowledge about anatomical variations in clinical and surgical contexts.

Case Report

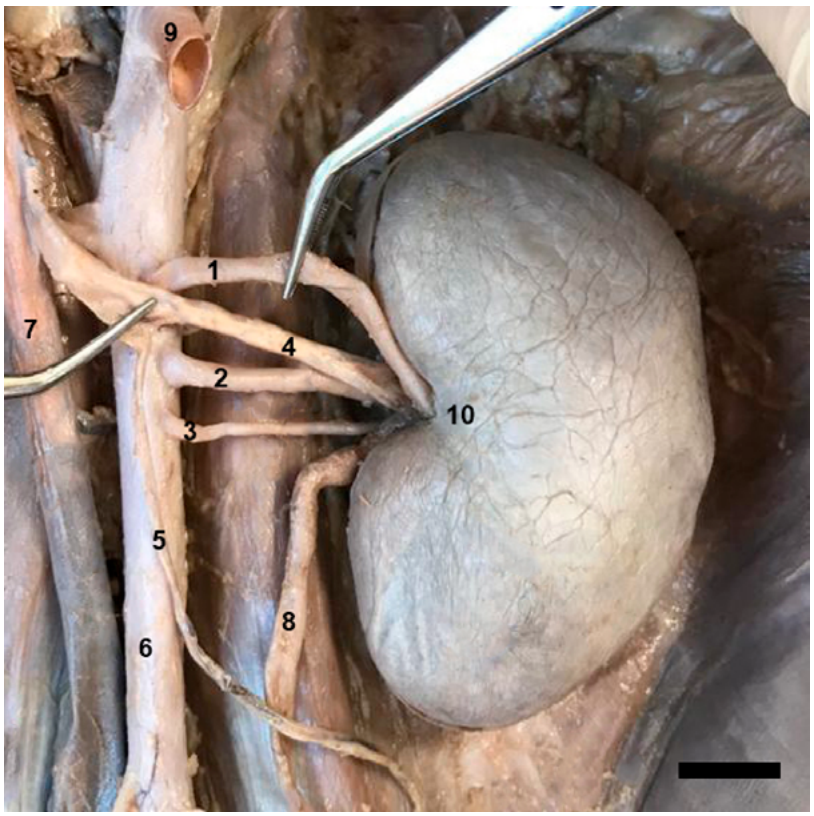
During dissection classes conducted in the Laboratory of Animal Anatomy at the Federal University of Pampa, a variation in the left renal artery of a male, adult, mongrel canine cadaver was observed. The corpse was donated by a local Veterinary Hospital and had been previously fixed in a 10% formaldehyde solution. The dissection classes were approved by the Ethics Committee on the Use of Animals (protocol 010/2022, CEUA–UNIPAMPA). Following the displacement of abdominal viscera, dissection exposed the renal pedicle, its origins, pathways, and the positions of the renal arteries. The dog did not have gross signs of renal disease.

The left kidney was supplied by three renal arteries: a cranial, an intermediate, and a caudal one. These three arteries left the abdominal aorta individually. The cranial and intermediate arteries originated ventrolaterally from the abdominal aorta with the same diameter (Figure 1). The most caudal artery had the narrower lumen. These three parallel arteries directed themselves to the renal hilum. The left renal vein was single and received the left testicular vein, as usual in dogs. The ureter had no remarkable changes. The right kidney had no vascular variations.

Discussion

Numerical variation, trajectory, and origin of visceral branches of the abdominal aorta are broad and diverse.

Figure 1. Photomacrography in ventral view of the cranial left renal artery (1), intermediate left renal artery (2), caudal left renal artery (3), left renal vein (4), left gonadal vein (5), abdominal aorta (6), caudal vena cava (7), left ureter (8), cranial mesenteric artery (9), and left renal hilum (10). Bar: 10 mm



Therefore, information about the numerical variation of renal arteries is beneficial for surgical and angiographic approaches in domestic and wild animals. In anatomy, the concept of normality encompasses a range of presentations, including both the most common and less common variations, which, while not abnormal, can have a significant influence on disease predisposition, symptomatology, clinical examination, investigation, and patient management, including surgical procedures (9). The dog from this report had no gross signs of renal injury and no clinical history of renal impairment. The formation of three renal arteries probably did not cause any clinical signs and, thus, can be classified as a numerical anatomical variation.

In studies on variations in canine renal arteries, cases of left renal artery duplication were documented in 29 out of 117 dissected dogs (6). A study involving 500 dogs (7) showed that in 99.4% of cases, the right renal artery was single; in 12.8% of cases, the left renal artery was duplicated; and only in 0.4%, the left renal artery was tripled. Marques-Sampaio et al. studied renal vascularization in 49 mongrel dogs and reported that 88.4% of kidneys were supplied by a single renal artery, 11.6% kidneys by double renal arteries, and found no triple renal artery (8). Sajjarengpong and Adirektaworn (9) investigated the renal arteries of 144 dogs and did not find triple renal arteries.

Indeed, an anatomical variant deviates from the "normal" arrangement of an anatomical structure without apparent impairment in its functioning (10), differing from pathological abnormalities that may affect the functioning of one or more anatomical structures.

While many anatomical variants do not require clinical attention, some may pose problems or indicate adverse symptoms (11).

Records of numerical variations in renal arteries from mammals include dogs (12), cats (13), rabbits (14), and crab-eating foxes (15), with these reports being more common than variations in renal veins. However, triple renal artery reports in dogs remain rare.

In humans, Khamanarong et al. (16) described variations in renal arteries, identifying a single renal artery in 81.64% of the 534 examined kidneys, double renal arteries in 17.43% of cases, of which 7.50% were double at the hilum, 6.93% were a hilum combined with a superior polar artery, and 3.00% were a hilum combined with an inferior polar artery. The presence of triple renal arteries was observed in only 0.93% of cases, with two presenting two hila combined with a superior polar artery and three presenting two hila combined with an inferior polar artery. Regarding the antimer, triple renal arteries were observed in 0.74% of right and 0.19% of left kidneys. Results of an angiotomographic study of kidneys conducted by Palmieri et al. (17) indicated a higher frequency of triple renal arteries in the right kidney.

Furthermore, understanding variations in the arrangement and distribution of renal arteries was also studied by Sampaio and Passos (4), who documented cases of duplications, triplications, and arterial branches supplying both the upper and lower poles of human kidneys. In these cases, the authors advocated for the term "multiple renal arteries," emphasizing that these segments do not have anastomoses, representing normal terminal branches equally relevant for renal blood supply. Consequently, they stressed that terms like "aberrant," "accessory," "extra," and "supernumerary" are not suitable, as they wrongly suggest irrelevance.

It is recognized that multiple renal arteries make renal transplants more complex (5) and are more associated with renal pathologies compared to organs supplied by a single renal artery (4). However, Troppmann et al. (18) observed a higher incidence of perioperative complications in renal donors with a single renal artery than with multiple renal arteries. In this case, the dog kidneys were symmetrical, and there were no macroscopic signs of renal pathologies.

Karmacharya et al. (19) highlighted the importance of understanding renal vascular anatomy in the efficiency and safety of surgical procedures, as accessory renal arteries can hinder the insertion of endovascular grafts in abdominal aortic aneurysms to prevent renal infarction.

Hence, abdominal surgical interventions involving hemostatic control of the left renal artery and its branches should include a careful analysis of vascular anatomical variations. The complexity of these variations can influence the technical options of a surgical procedure.

This report alerts that numerical variations in canine renal arteries must be considered in imaging techniques, surgical, and experimental procedures to avoid errors from unfamiliarity with the possibility of triple renal arteries occurring.

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