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Branching Pattern and Distribution of the Renal Arteries in Donkeys *(Equus asinus)*

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Abstract

THE KIDNEY is an essential organ in the mammalian body and has become a prominent focus of medical research. A thorough understanding of the branching patterns and courses of arterial vessels within the kidney is crucial, particularly when performing surgical procedures such as nephrectomy, renal transplantation, and renal biopsy. This study was conducted on the kidneys of ten adult donkeys. They were ethically anesthetized, euthanized, and embalmed. The extra-renal branching pattern was documented through gross examination. Following this, the kidneys of five donkeys were resected along with their intact renal arteries and subjected to radiographic analysis to illustrate both the excretory renal system and the distribution pattern and course of the arterial vessels within the kidneys. In most cases examined, the right and left renal arteries were represented by a single, robust stem originating from the lateral aspects of the abdominal aorta, just caudal to the origin of the cranial mesenteric artery. Each renal artery is subsequently divided into cranial, caudal, and hilar primary branches, subdivided into dorsal and ventral secondary branches. Notably, in one exceptional case, the left three primary divisions arose independently from the abdominal aorta. The interlobar arteries and their subdivisions from the secondary branches demonstrated nearly typical distribution, similar to that found in most other animals. This study underscores the significance of understanding the branching patterns and distribution of the renal artery in donkeys, highlighting key anatomical features that are crucial for veterinary studies and practices.

Keywords: Donkey, Renal Arteries, Branching Pattern, Distribution

Introduction

The donkey is a crucial domesticated animal, particularly in arid and semi-arid regions. Its remarkable ability to adapt to harsh climates, which often feature limited water supplies and high temperatures, makes it an invaluable livestock species for transportation, agriculture, and rural livelihoods [1].

The kidney is an essential organ in the mammalian body and a significant focus of medical research, and analyzing the blood vessels of kidneys in both domestic and wild animals is crucial for understanding various aspects of their physiology and nutrition [2]. Thorough comprehensions of the anatomy of the renal arteries is vital for conducting surgical procedures such as renal biopsy [3] and nephrectomy [4]. Moreover, variations in the origin and distribution patterns of renal arteries are important for clinicians undertaking surgeries or interventional procedures involving the kidneys [5]. These variations have also played a significant role in the increasing prevalence of experimental renal transplantation, vascular reconstruction for congenital and acquired lesions, and the management of abdominal aortic aneurysms [6].

Understanding the variations in renal vasculature is crucial for the examination and treatment of renal trauma, kidney transplantation, renal vascular hypertension, and renal artery embolization in various mammalian species, given the limited literature on renal artery branching in

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donkeys. So, this study aims to clarify the branching patterns and arterial distribution in donkeys.

Material and Methods

Animals

The work was conducted on the kidneys of ten apparent healthy adult donkeys,4-5 years' age, and 170:200 kg. body weight. The donkeys were sedated by intravenous administration of xylazine (0.5 mg/kg), according to [7], and ethically euthanized by properly bled through the common carotid artery according to [8, 9]. Five animals were embalmed by injection via the common carotid artery with a mixture of 15% formalin, 15% glycerin, 5% methanol, 10% phenol, and 55% water according to [10].

Techniques

The extra-renal branching pattern of the renal arteries were thoroughly dissected, documented through gross examination of the ten cases, and photographed.

The kidneys of five non-embalmed donkeys were resected along with their intact renal arteries and subjected to radiographic analysis using SIMENS MULTIX at K.V. 70 and M.A./S. 32, after injecting with barium sulfate suspension (BaSO4; M.W. 233.39; OXFORD LAB FINE CHEM LLP) for studying detailed extra, and intra-renal branching pattern of the renal arteries.

Nomenclature was adopted according to the Nomina Anatomica Veterinaria (2017), 6th. ed. [11].

Results

In most examined kidneys, both the right and left renal arteries *(Aa. Renales, dexter et sinister)* typically originated from a single, pronounced stem located on the corresponding lateral aspect of the abdominal aorta, just caudal to the origin of the cranial mesenteric artery (Figs. 1, 3, 4, and 5). Notably, the right renal artery was slightly longer and originated more cranially than the left renal artery. In a rare case, the left renal artery *(A. renalis sinister)* emerged by three distinct branches on the left side of the abdominal aorta (Figs. 2/ 7, 8, and 9). These branches included a small caudal branch (Fig. 2/9) that entered the renal tissue at the caudal renal pole, a medium-sized cranial branch (Fig. 2/7) supplied the cranial renal pole, and a large hilar branch (Fig. 2/8) extended towards the renal hilus, where it divided into dorsal (Fig. 2/8/a) and ventral (Fig. 2/8/b) hilar branches.

In most instances, the right renal artery *(A. renalis dexter)* (Fig. 2/2) detached near the medial border of the right kidney, giving rise to a relatively small primary cranial branch *(Ramus cranialis)* (Fig. 2/3) that extended toward the renal hilus and directly entered the cranial pole of the right kidney. The continuation of the renal artery further produced one or two hilar branches (2/4,5), as well as a primary caudal branch *(Ramus caudalis)* (2/6). The caudal branch penetrated the caudal pole of the right kidney, while the hilar branches, when two were present, were identified as dorsal and ventral hilar branches. If only a single branch was present, it would be subdivided into dorsal and ventral branches, supplying the corresponding regions of the middle renal area.

In certain instances, the right renal artery bifurcates at the renal sinus into a prominent cranial branch *(R. cranialis)* (Fig. 1/3) and another substantial branch. The cranial branch supplied the cranial pole of the kidney through a larger ventral subdivision (Fig. 1/3a) and a smaller dorsal subdivision (Fig. 1/3b). The dorsal branch continued toward the renal sinus, where it further divided into a robust dorsal hilar branch (Fig. 1/5) and a common trunk that leads to both the ventral hilar and caudal renal branches (Figs. 1/6, 1/7). In another case, the cranial primary branch (Figs. 3/3, 4/3) splined into two nearly equal secondary branches, dorsal and ventral. The renal artery continues toward the renal sinus, where it divides into a substantial hilar branch (Fig. 3/4) and a relatively smaller caudal primary branch (Figs. 3/7, 4/6). Both the hilar and caudal branches are further subdivided into dorsal and ventral secondary divisions (Figs. 3, 4).

The left renal artery *(A. renalis sinister)* (Fig. 3/8) branched into three primary divisions after originating from the abdominal aorta. These included a left cranial branch *(Ramus cranialis sinister)* (Fig. 3/9) supplying the cranial renal pole, a left caudal branch *(Ramus caudalis sinister)* (Fig. 3/12) that supplied the caudal renal pole, and a left hilar branch that further divided into dorsal (Fig. 3/11) and ventral (Fig. 3/10) branches directed toward the renal sinus, supplying the middle renal region (Fig. 3).

In another description, the left renal artery divided into four primary branches before reaching the renal sinus. These consisted of a left cranial branch *(Ramus cranialis sinister)* (Fig. 5/2) supplying the cranial renal pole, a left caudal branch *(Ramus caudalis sinister)* (Fig. 5/3) that reached the caudal renal pole, and two hilar branches (Figs. 5/4,5) that extended into the renal hilus and further subdivide toward the middle renal region.

In both the right and left kidneys, each of the three primary branches is further bifurcated into dorsal and ventral secondary branches. This resulted in a total of six secondary branches for each kidney. From these secondary branches, interlobar arteries arose, extending into the medullary tissue up to the medullary-cortical junction, where they curved to form arcuate arteries *(Arteriae Arcuatea)* (Figs. 6/B, 7/B). Interlobular arteries *(Arteriae interlobulares)* originated from the arcuate arteries, resulting in a sequential branching pattern of renal arterial distribution. The number of interlobar arteries derived from the six secondary divisions in both kidneys can vary; however, it typically ranges from 19 to 22 in each kidney. Some of the interlobular arteries pierced the fibrous capsule to supply the perirenal fat.

Grossly, it wasn't easy to recognize anastomoses between the adjacent arcuate arteries

Discussion

The present study builds upon the foundational work of various researchers regarding the origin of renal arteries in different species. [12] studied donkeys, [13] examined domestic animals, [14] focused on bovine calves, [15] investigated van cats, [16] researched camels, and [17] explored the hasak sheep. All these studies indicate that the renal arteries originate from the lateral aspects of the abdominal aorta, just caudal to the cranial mesenteric artery. In contrast, [18] found that in dogs, the renal arteries arise from the ventral surface of the abdominal aorta. Additionally, the kidneys of goats receive blood supply from the right and left renal arteries, which emerge from the ventromedial wall of the abdominal aorta, midway between the 3rd and 4th lumbar transverse processes) [19]. In their study, [20] described the presence of two right renal arteries in horses.

A review of the literature shows that there is limited research on the perihilar branching pattern of the renal arteries. However, understanding this branching pattern is essential, especially with the advancements in radiological diagnostic technology [21]. In the study under investigation, and in one notable case, the left renal artery of a donkey was found to originate as three separate branches from the abdominal aorta: cranial, caudal, and hilar. Additionally, in some instances, the caudal branch of the right kidney in donkeys has been observed to emerge directly from the aorta [12]. Furthermore, in a rare case documented by [22], both the dorsal, and ventral divisions of the renal artery were noted to originate independently from the aorta in camels.

Investigating the shape and branching patterns of the renal arteries is crucial for minimizing complications during kidney transplantation and surgical procedures [21]. However, the lack of extensive literature addressing the extra renal branching patterns of renal arteries poses a challenge for the authors, making it difficult to compare the variations observed in this study with those found in other animal species.

The present search, revealed that each renal artery is subdivided into three primary branches: cranial, hilar, and caudal. This finding is consistent with the work of [12], who identified three branches in the right kidney of donkeys (caudal, dorsal, and ventral), and three in the left kidney (cranial, dorsal, and ventral). Additionally, [23] noted that in bovines, the renal artery divides into cranial, hilar, and caudal primary segmental arteries in 11.36% of cases, aligning with our findings. In camels, each renal artery bifurcates into dorsal and ventral divisions, as reported by several studies [24]; [16]; [22]; and [25]. Similar patterns have also been observed in buffalo [26], sheep [27]; [28], goats [29], and dogs [30]. Furthermore, [23] found that in bovines, the renal artery divides into cranial and caudal primary segmental arteries in 84.1% of cases. In contrast, [31] indicated the presence of a third branch originating from the renal artery in sheep. [23] also noted that in 4.54% of bovine cases, four branches may arise from the renal artery: two cranial, one hilar, and one caudal primary segmental artery.

The current study found that the number of interlobar arteries in each kidney ranged from 19 to 22. In contrast, [12] observed 14 to 20 interlobar arteries in the right kidney and 9 to 10 in the left kidney of the same animal. In sheep, [17] recorded 12 to 14 interlobar arteries in each kidney, while [32] reported only 2 to 5 interlobar arteries in the same species. [33] noted that each kidney in Capra hircus had 4 to 5 interlobar arteries. [25] found that camels had 6 to 8 interlobar arteries in the left kidney and 8 in the right kidney. In dogs, [34] reported 9 to 12 interlobar arteries in the right kidney and 11 to 15 in the left. There are significant ethnic and racial differences in the renal artery branches and branching patterns [21].

Conclusion

A thorough understanding of the structural variations of renal arteries is essential for effectively evaluating renal angiograms. These arteries function as end arteries, meaning that any obstruction can lead to degeneration of the kidney segment they supply.

This complexity creates significant challenges during kidney transplant procedures, as damage to these arteries can result in postoperative hemorrhage. To preserve the renal segment during surgery, it is critical for urologists to maintain each of the multiple renal arteries. Consequently, performing a renal angiography prior to surgery is vital. Furthermore, surgeons must be cognizant of renal artery variations, as an inadvertent rupture during renal surgery can lead to severe bleeding or infarction of the renal parenchyma.

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Declaration of Conflict of Interest.

The authors declare that there is no conflict of interest.

Ethical of approval.

This study follows the ethics roles of the Research Ethics Committee, of the Faculty of Veterinary Medicine, Suez Canal University, Ismailia, Egypt. (Ethics Approval Number (2022027/ 08-2022)

Acknowledgement: Not applicable

Figures:

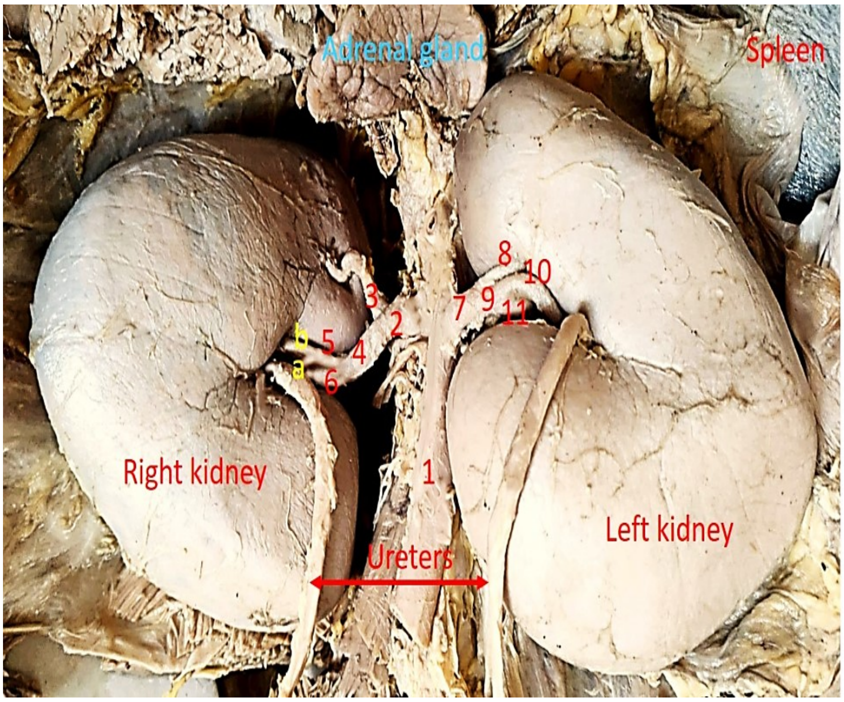

Fig. 1. A photograph of a donkey's kidneys, illustrating the origin and extra renal branching patterns of the renal arteries.

1. Abdominal Aorta *(Aorta abdominalis),* 2. Right Renal Artery *(A. renalis dexter)*, 3. Right Cranial Branch *(Ramus cranialis dexter)*, 4. Right Hilar Branch, a. Dorsal Branch of the Right Hilar Branch *(Ramus dorsalis* de right hilar branch), b. Ventral Branch of the Right Hilar Branch *(Ramus ventralis* de right hilar branch), 5. Caudal Branch of the Right Renal Artery *(Ramus caudalis de A. renalis dexter),* 6. Left Renal Artery *(A. renalis sinister),* 7. Left Cranial Branch (Ramus cranialis sinister), 8. Left Hilar Branch, 9. Caudal Branch of the Left Renal Artery (Ramus caudalis de A. renalis sinister),

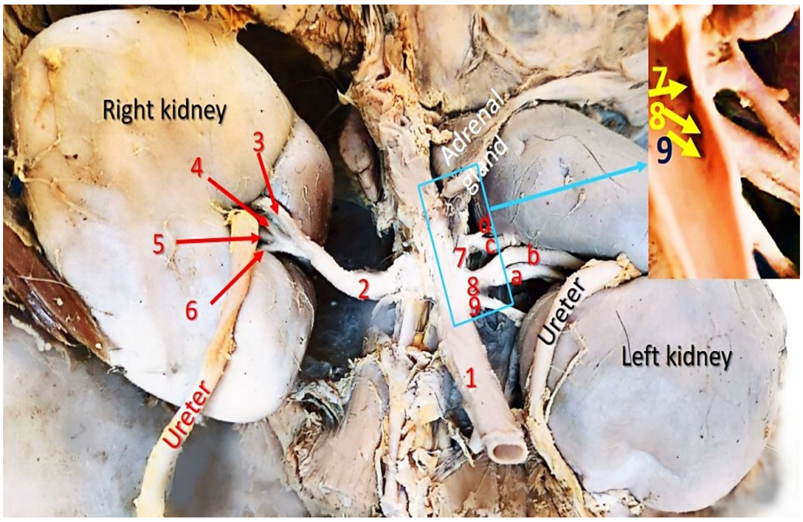

Fig. 2. A photograph of a donkey's kidneys, showing the origin and branching pattern of the renal arteries.

1. Abdominal aorta *(Aorta abdominalis),* 2. Right renal artery *(A. renalis dexter),* 3. Right cranial branch *(Ramus cranialis dexter),* 4. Dorsal branch of the right hilar branch (Ramus dorsalis de right hilar branch), 5. Ventral branch of the right hilar branch *(Ramus ventralis* of right hilar branch), 6. Caudal branch of the right renal artery *(Ramus caudalis de A. renalis dexter),* 7. Cranial branch of the left renal artery *(Ramus cranialis de A. renalis sinister),* dividing into: c. Dorsal branch of the cranial branch *(Ramus dorsalis de Ramus cranialis),* and d. Ventral branch of the cranial branch *(Ramus ventralis de Ramus cranialis).*

8. Left hilar branch dividing into: a. Dorsal branch of the left hilar branch *(Ramus dorsalis* of left hilar branch), and b. Ventral branch of the left hilar branch (*Ramus ventralis* of left hilar branch), 9. Caudal branch of the left renal artery *(Ramus caudalis de A. renalis sinister)* dividing into:

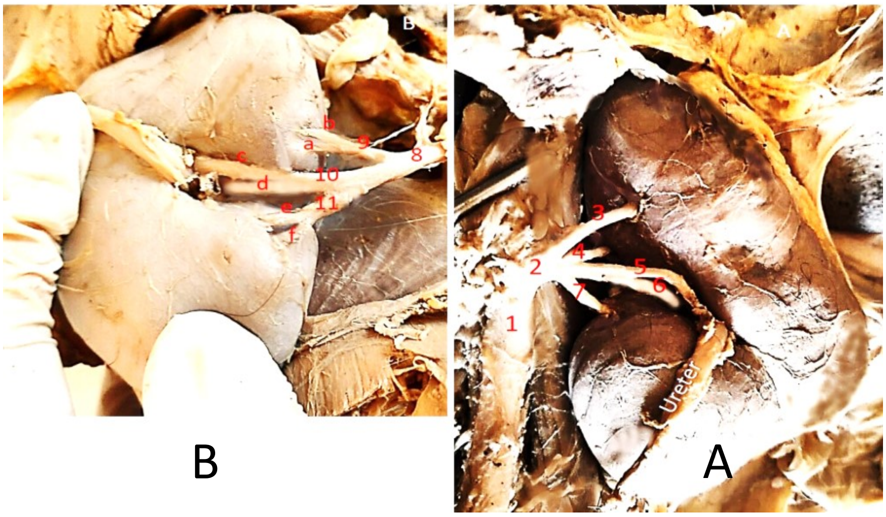

Fig. 3. A photograph of a donkey's left (A) and right (B) kidneys, illustrating the origin and branching patterns of the renal arteries, ventral view).

1. Abdominal aorta *(Aorta abdominalis),* 2. Left renal artery *(A. renalis sinister),* 3. Left ventral cranial branch (Ramus cranialis vetntralis sinister), *4.* Left dorsal cranial branch (Ramus cranialis dorsalis sinister). 5. Left ventral hilar branch, 6. Left dorsal hilar branch, 7. Left caudal branch (Ramus caudalis sinister), 8 Right renal artery (*A. renalis dexter*), 9. Right cranial branch *(R. cranialis dexter)* dividing into a. *R. dorsalis*, and b. *R. vetntralis*), 10. Right hilar branch, derives, c. *Ramus vetntralis, and d. R. dorsalis, 11. Right caudal branch (R. caudalis dexter), derives, e. ventral branch, and f. dorsal branch*

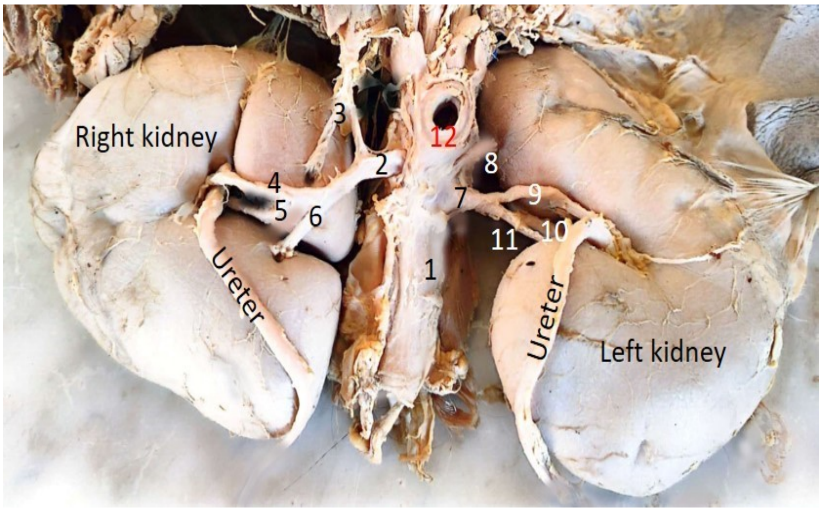

Fig. 4. A photograph of a donkey's kidneys, showing the origin and branching pattern of the renal arteries.

1. Abdominal aorta *(Aorta abdominalis),* 2. Right renal artery *(A. renalis dexter)*, 3. Right cranial branch *(Ramus cranialis dexter),* 4. Right ventral hilar branch *(Ramus ventralis* of right hilar branch), 5. Right dorsal hilar branch *(Ramus dorsalis* of right hilar branch), 6. Right caudal branch *(Ramus caudalis dexter),* 7. Left renal artery (*A. renalis sinister),* 8. Left cranial branch *(Ramus cranialis sinister)*, 9. Left ventral hilar branch *(Ramus ventralis* of left hilar branch), 10. Left dorsal hilar branch *(Ramus dorsalis* of left hilar branch), 11. Left caudal branch *(Ramus caudalis sinister), 12.* Stump of the cranial mesenteric artery

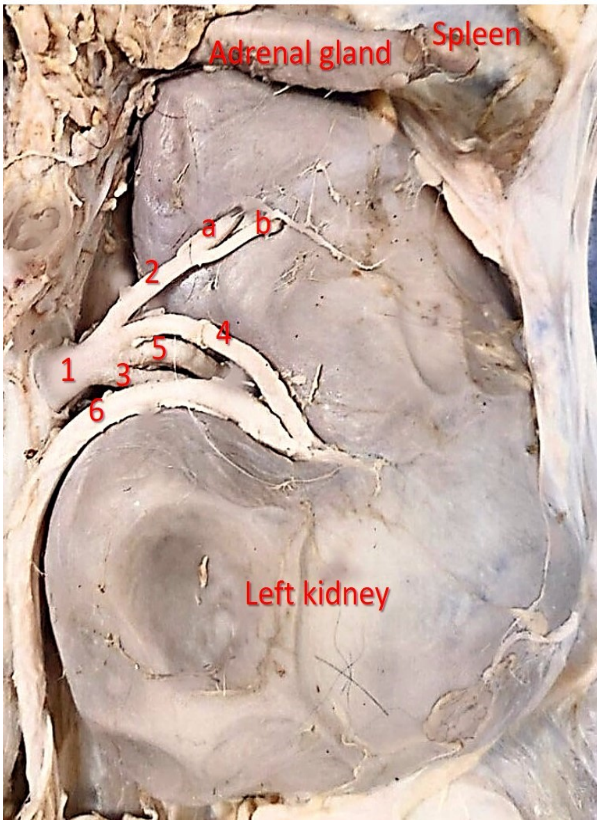

Fig. 5. A photograph of a left donkey's kidney, illustrating the origin and branching pattern of the renal arteries.

1. Left renal artery *(Arteria renalis sinistra),* 2. Cranial branch *(Ramus cranialis)* that dividing into: a. dorsal branch *(R. dorsalis), and b.* ventral branch *(R. Ventralis),* 3. Caudal branch *(Ramus caudalis),* 4. Ventral hilar branch, 5. Dorsal hilar branch, 6. Ureter

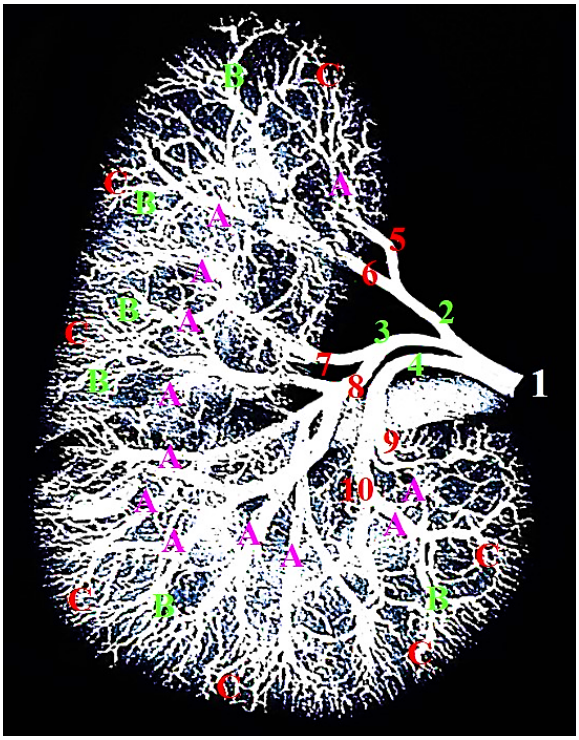

Fig. 6. This radiograph illustrates the left kidney of a donkey in a dorsoventral view, highlighting the branching pattern and distribution of the left renal artery.

1. Left renal artery (*A. renalis sinister),* 2. *Left cranial branch (Ramus cranialis sinister),* 3. Left hilar branch, 4. Left caudal branch (*Ramus caudalis sinister),* 5. Left cranial ventral branch (*Ramus ventralis cranialis sinister),* 6. Left cranial dorsal branch (*Ramus dorsalis cranialis sinister),* 7. *Ramus ventralis* of the left hilar branch, 8. *Ramus dorsalis* of the left hilar branch, 9. Left caudal ventral branch (*Ramus ventralis caudalis sinister),* 10. Left caudal dorsal branch (*Ramus dorsalis caudalis sinister)*, A. Interlobar arteries (*Arteriae interlobares)*, B. Arcuate arteries (Arteriae arcuatea), C. Interlobular arteries (*Arteriae interlobulares)*.

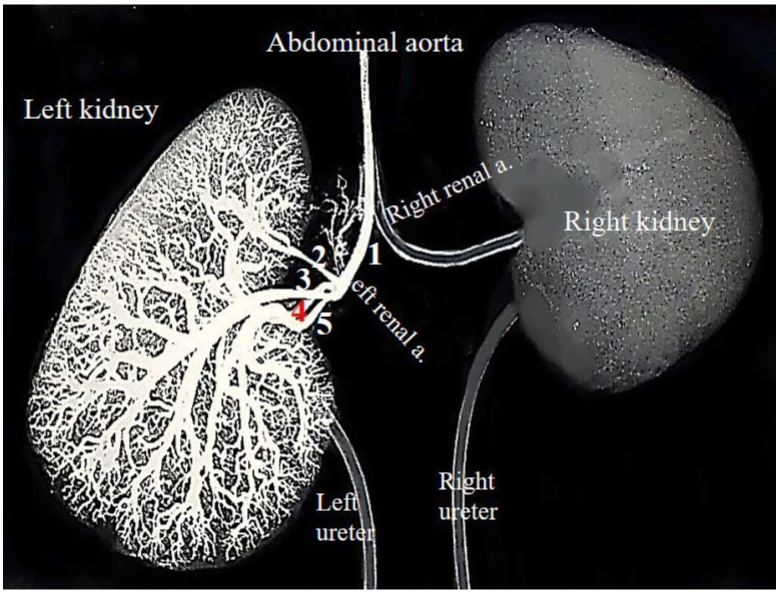

Fig. 7. A radiograph of a donkey's kidneys, viewed from a dorsoventral perspective, illustrates the branching pattern and distribution of the left renal artery.

The components are labeled as follows: 1. Left renal artery *(A. renalis sinister),* 2. Cranial primary branch of the left renal artery *(Ramus cranialis sinister),* 3. Dorsal branch of the left hilar branch *(Ramus dorsalis* of the left hilar branch), 4. Ventral branch of the left hilar branch *(Ramus ventralis* of the left hilar branch) 5. Caudal primary branch of the left renal artery *(Ramus caudalis sinister).*

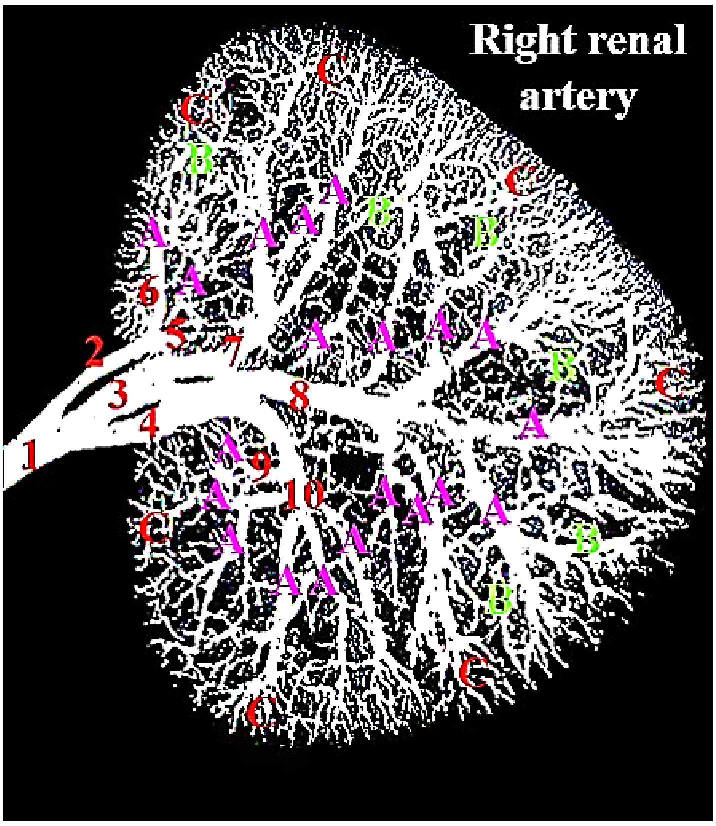

Fig. 8. This radiograph depicts the right kidney of a donkey in a dorsoventral view, highlighting the branching pattern and distribution of the right renal artery.

1. Right renal artery (A. renalis dextra), 2. Cranial primary branch (Ramus cranialis dexter), 3. Hilar branch 4. Caudal primary branch (Ramus caudalis dexter), 5. Dorsal secondary branch of the cranial primary branch (Ramus dorsalis), 6. Ventral secondary branch of the cranial primary branch (Ramus ventralis), 7. Dorsal hilar branch (Ramus dorsalis of the right hilar branch), 8. Ventral hilar branch (Ramus ventralis of the right hilar branch), 9. Dorsal secondary branch of the caudal primary branch (Ramus dorsalis caudalis dexter), 10. Ventral secondary branch of the caudal primary branch (Ramus ventralis caudalis dexter), A. Interlobar arteries (Arteriae interlobares), B. Arcuate arteries (Arteriae arcuatea), C. Interlobular arteries (Arteriae interlobulares).

References

1. Smith, D.G. and Pearson, R.A.: A review of the factors affecting the survival of donkeys in semi-arid regions of sub-Saharan Africa. *Tropical Animal Health and Production*, **37**, 1-19 (2005).
2. de Moraes Barros, P.S., de Souza, W.M., Rodrigues, R.F., Guimarães, J.P., Miglino, M.A. and Borelli, V.: Topography of arterial and venous blood vessels in the kidneys of English Thoroughbred Horses. *Braz. J. Vet. Res. Anim. Sci.*, **52** (1), 6-14 (2015).
3. Naoi, M., Kokue, E., Takahashi, Y. and Kido, Y: Laparoscopic assisted serial biopsy of the bovine kidney. *American Journal of Veterinary Research,* **46**, 699–702 (1985).
4. Bagetti Filho HJS: Bovine kidney collecting system analysis contribution for research in urology. *Brazilian Journal of Morphological Science*, **25**, 1–34 (2008).
5. Walizai, T., Bashir, O., Hacking, C., Jones, J., Sharma R. and Knipe, H., Renal artery. Reference article, Radiopaedia.org https://doi.org/10.53347/rID-16696, https://radiopaedia.org/articles/16696, (Last revised on 2024).
6. Toribio, R.E.: Essentials of equine renal and urinary tract physiology. *Vet. Clin. N. Am.: Equine Pract.,* **23**, 533-561(2007).
7. Harrison, Lynn H. Jr.; Flye, M. Wayne; Seigler, H. F.: Incidence of Anatomical Variants in Renal Vasculature in the Presence of Normal Renal Function. *Ann. Surg.,* **188** (1), 83-89(1978).
8. Gomaa N. A. , Alaa E. Ghazy, Ayman S. Atiba: Effect of repeated intravenous administration of xylazine on sedation, analgesia and ECG parameters in donkeys (*Equus Asinus*). *Assiut Veterinary Medical Journal*, **61** (147), 124-130 (2015).
9. Fatma A. Elsaid, Hisham M. Imam, Walaa A. Basha, and Saber M. Abuzeid: Comparative Anatomical study on the Lower Respiratory Airway of Domestic Animals, Including Descriptive Anatomy of the Donkey's Trachea (A Model for Electronic Learning Module). *SCVMJ,* **XXIX** (1), 183- 208, (2024)
10. Fatma A. M. Elsaid, Saber M. Abuzeid, Hisham M. Imam, and Walaa A. Basha: Comparative Morphological Studies on the Lungs of Domestic

Animals (Bases for Developing Electronic Learning Module), *Egypt. J. Vet. Sci.,* **56**, (8), 1-31 (Published online, August, 2024).

11. LyndaTamayo-Arango and AndersonGarzón-Alzate., Preservation of Animal Cadavers with a Formaldehyde-free Solution for Gross Anatomy. *Journal of Morphological Sciences*, **30** (2), 136-141. (2018)

12. Nomina Anatomica Veterinaria: Prepared by the International Committee on Veterinary Gross Anatomical Nomenclature (I.C.V.G.A.N.), Published by the Editorial Committee, Hanover (Germany), Ghent (Belgium), Columbia, MO (U.S.A.), Rio de Janeiro (Brazil) With permission of the World Association of Veterinary Anatomists (W.A.V.A.), 6th. ed. (2017)

13. Osman, F. A. and Ragab, S.: Anatomical studies on the renal blood vessels of donkey (Equus asinus). *Assiut Vet. Med. J.* **18,** (36), 7-17 (1987)

14. Nickel, R., Schummer, A. and Seiferle, E., The Anatomy of the Domestic Animals. Vol. 3. The Circulatory System, the Skin,and the Cutaneous Organs of the Domestic Mammals. Verlag Paul Parey, Berlin and Hamburg. (1981).

15. Jain, R.K. and Singh, Y., Vascularization of kidneys in bovine calves. *Indian Veterinary Journal*, **64**, 1059–1062. (1987).

16. Aksoy, G. and Ozudogru, Z., A macroscopical investigation on the intrarenal segmentation of the renal arteries in the Van Cat. *Kafkas Univ. Vet. Fak. Derg.*, **9**, 9-13 (2003).

17. Mohammad Reza Paryani.: Intrarenal patterns of the vascular supply in one-humped camel (*Camelus dromedarius*). *Scholars Research Library, Annals of Biological Research*, **3** (10), 4947-4950(2012).

18. Özüdoğru, Z., Özdemir, D. and Balkaya, H.: Arterial vascularization of kidneys in the Hasak sheep. *Fırat Üniversitesi Sağlık Bilimleri Dergisi*, **31** (3), 303147 (2017).

19. Ghoshal, N.G.: Carnivores heart and arteries. In: Getty R. (Ed.), *Sisson and Grossman's the Anatomy of the Domestic Animals*. 5th ed. W.B. Saunders Company, Philadelphia. (1975).

20. Elkarmoty, A.M.R., Daghsh, S. and Abdelnaby, E., Some anatomical studies on the kidney of goat (*Capra hircus*) with special reference to angioarchitecture, ultrasonography and Doppler. *Turkish Journal of Veterinary & Animal Sciences*, **46** (4), Article 3. (2022).

21. Shojaei, B., Kheirandish,R. and Azizi, S., Morphological Observation of a Horseshoe (fused) Kidney and its Vascular Pattern in a Horse. *Anat. Histol. Embryol.,* **41**, 388–391. (2012)

22. Arasu, A. T., Muniappan Veerappan, Sundarapandian Subramanian and Ananthi Varadharajan: Variations in the branching pattern of renal artery. *Asian Journal of Medical Sciences*, **13**(12),48- 54(2022).

23. Elayat, M., Khalifa, E., Daghsh, S. and Mohamed, M.: Anatomical relationships between the renal segmental arteries and kidney collecting system of camel. *Veterinary Medical Journal (Giza)*, **62** (3), 23-30 (2016).

24. Szymanski, J., Olewnik, L., Wysiadecki, G., Przygocka, A., Polguj, M., Topol, M.: Proposal for a new classification of the renal artery in the bovine kidney. *Veterinární Medicína*, **63** (2),63-72 (2018).

25. El-Shaieb, M.O., Fathel, El-Bab M.R. and Saber, A.S.: The arcuate arteries and their branches in the kidney of *Camelus dromedarius*. *Assiut Veterinary Journal*, **8**, 9-11 (1981).

26. Li, H., Cui, Y., Wang, Y., Qiu, H., Afedo, S.Y., Huang, Y. and Bai, X.: Distribution and microstructure of Intrarenal arteries in Bactrian camels (*Camelus bactrianus*). *Histol. Histopathol.,* **35**(3), 279-287 (2020).

27. Gahlot, R., Pahuja, K. and Gahlot, N.K.: Study of renal arterial segmentation in mammals by corrosion cast. *Asian Journal of Pharmaceutical and Health Sciences*, **4** (4), 1154-1157 (2014).

28. Michalczyk, K., Mierzwa, A., Mierzwa J., Chuchla M.: Arteries of the kidney in domestic sheep. *Folia Morphol.*, **44**, 232-240 (1985).

29. Buys-Gonçalves G.F., De Souza D.B., Sampaio F.J. and Pereira-Sampaio M.A.: Anatomical relationship between the kidney collecting system and the intrarenal arteries in the sheep: Contribution for a new urological model. *Anat. Rec. (Hoboken)*, **299**, 405-411(2016).

30. Aslan, K.A. and Mumtaz Nazli, M.N.: A comparative macro-anatomic investigation on the intrarenal segmentation of the renal artery in goats and Morkaraman sheep. *Indian Veterinary Journal* **78**, 139- 143 (2001).

31. Fuller, P.M. and Huelke, D.F.: Kidney vascular supply in the rat, cat, and dog. *Acta Anatomical*, **84**, 516–522 (1973).

32. Aksoy, G., Kurtul, I., Ozcan, S., Aslan, K. and Ozudogru, Z.: Intrarenal arteries and their patterns in the Tujsheep. *Veterinarian Medicine*, **49**, 57–60. (2004).

33. Özdemir, D. and Özüdoğru, Z.: Macroanatomical investigations on renal arteries of southern Karaman sheep. *Turkish Journal of Agriculture - Food Science and Technology* **8**(9), 1878-1881 (2020).

34. Jabbar, A.I., Kareem Ali, H., Ibrahim, R.S. and Lateef, A.N.: Anatomical and histological investigation of the kidney in goat (*Capra hircus*). *Diyala Agricultural Sciences Journal*, **10** (Special Issue), 1-12. (2018)

35. Özdemir, D., Ozudogru, Z. and Malkoc, I.: Intrarenal segmentation of the renal arteries in the Kangal dog. *Kafkas Universitesi Veteriner Fakultesi Dergisi*.. **15** (1), 41-44(2009).

نمط تفرع وتوزيع الشرايين الكلوية في الحمير

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الملخص

تعتبر الكلى هي عضو أساسي في جسم الثدييات وأصبحت محورا بارزا للبحوث الطبية. يعد الفهم الشامل لأنماط ودورات الأوعية الشريانية المتفرعة داخل الكلى أمرا بالغ الأهمية ، خاصة عند إجراء العمليات الجراحية مثل خزعة الكلى. أجريت هذه الدراسة على كلى عشرة حمير بالغة يتراوح عمرها من 4 : 5 سنوات وتزن من 170: 200 كجم، والتي تم التعامل مها طبقا للمعايير المنظمة لأخلاقيات إستخدام الحيوان في البحوث العلمية من حيث التخدير والقتل الرحيم والتحنيط.

تم توثيق نمط التفرع خارج الكلى من خلال الفحص العياني. بعد ذلك ، تم استئصال كليتي خمسة حمير مع شرايينها الكلوية السليمة وإخضاعها للتصوير والتحليل الإشعاعي لتوضيح كل من الجهاز الكلوي الإخراجي ونمط توزيع ومسار الأوعية الشريانية داخل الكلى.

في معظم الحالات التي تم فحصها ، تم تمثيل كل من الشرايين الكلوية اليمنى واليسرى بجذع واحد قوي ينشأ من الجوانب الجانبية للشريان الأورطي البطني ، خلف الشريان المساريقي الأمامي. ينقسم كل شريان كلوي بعد ذلك إلى فروع أولية أمامية وخلفية والنقيرية ، والتي تنقسم بدورها إلى فروع ثانوية ظهرية وبطنية. والجدير بالذكر أنه في حالة استثنائية واحدة ، نشأت الأفرع الأولية الثلاثة للكلى اليسرى بشكل مستقل من الشريان الأورطي البطني مباشرة.

هذا وقد أظهرت الشرايين بين الفصوص وتقسيماتها الفرعية من الفروع الثانوية توزيعا نموذجيا مشابها لتلك الموجودة في معظم الحيوانات الأخرى.

تؤكد هذه الدراسة على أهمية فهم أنماط تفرعات وتوزيع الشرايين الكلوية في الحمير ، مع تسليط الضوء على السمات التشريحية الرئيسية التي تعتبر حاسمة للدراسات والممارسات البيطرية.

الكلمات الدالة: الحمار ، الشرايين الكلوية ، نمط التفرع ، التوزيع.