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Anatomical Variations in the Celiac Trunk, Cranial and Caudal Mesenteric Arteries of the Domestic Cat: Surgical Implications

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ABSTRACT

This study aimed to investigate the anatomical characteristics and to determine the branching architectural pattern of the celiac trunk, cranial mesenteric artery, and caudal mesenteric artery in the domestic cat. In this study, 20 domestic cats of both sexes were examined. After recording body weight and crown-rump length, colored latex was injected into the thoracic aorta via a cannula. Following a one-week preservation period in formalin, the specimens were dissected. The branching patterns of the celiac trunk, and the cranial and caudal mesenteric arteries were evaluated through meticulous dissection and digital documentation. Additionally, the morphometric properties of the vessels were measured and recorded using a digital caliper. Dissection findings revealed that the branching pattern followed a consistent anatomical order in the majority of specimens, and no unusual variations were observed. In all cases, the celiac trunk, with a mean length of 17.43 ± 3.70 mm, divided into three main branches: the hepatic, left gastric, and splenic arteries. The cranial mesenteric artery, with a mean length of 29.08 ± 4.14 mm, formed a network of 11 to 14 jejunal branches after its initial trifurcation. The caudal mesenteric artery, with a mean length of 25.45 ± 3.33 mm, terminated by bifurcating into the left colic and cranial rectal arteries. Based on the results of this study, the domestic cat exhibits a stable and standard vascular pattern in the main branches of the abdominal aorta. Establishing this reference model and determining the precise vertebral positions can serve as a key guide to enhance precision in abdominal surgeries and the interpretation of angiographies in veterinary clinics.

Introduction

The improvement of diagnostic methods and advancements in surgical techniques for gastrointestinal diseases have expanded the knowledge of anatomy in medical and veterinary sciences. Numerous studies have been conducted to acquire new information regarding the distribution pattern of intestinal arteries. The primary goals of these studies are to improve intestinal reperfusion following ischemia and to identify anatomical variations during angiography.[1-5]

While the intestinal blood supply has been investigated in various animals,[6,7] there is limited information regarding the arrangement and morphometric evaluation of blood vessels in the abdominal cavity of cats.[1,5,8-11] Among the visceral branches of the abdominal aorta, the celiac trunk and the cranial and caudal mesenteric arteries are of paramount importance in clinical anatomy, surgery, and angiographic procedures due to their role in supplying blood to different parts of the gastrointestinal tract, such as the liver, spleen, stomach, pancreas, and intestines. These arteries originate from the ventral aspect of the abdominal aorta. Several studies on the

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branching pattern of the celiac trunk in various animals have shown that the branching and division of these vessels can vary across different species, and even within individuals of the same species.[12] The domestic cat, which is utilized in laboratory research, is widely kept as a companion animal, and a substantial diversity of breeds also exists in the wild. Cats are highly intelligent and specialized mammals possessing morphological adaptations and sensory capabilities tailored to their unique requirements.[13] Given the continuous advancements in diagnostic methods for companion animals, evaluating and thoroughly understanding arterial branching patterns plays a crucial role in the diagnosis and treatment of numerous abdominal disorders.[14] The gastrointestinal tract is of immense importance due to its role in body metabolism and nutrient processing. Considering the variations in blood vessel branching that can occur even within the same animal species, the objective of this study was to establish a reference model for the architectural pattern and frequency of anatomical variations in the branches of the celiac trunk, as well as the cranial and caudal mesenteric arteries in the domestic cat. This baseline model aims to provide valuable insights for pathological assessments, surgical interventions, and diagnostic imaging procedures.

Materials and Methods

A total of 20 adult domestic cats (comprising 11 females and 9 males) with an average weight of 4.2 kg were used in this study. All animals were obtained from veterinary clinics in Tabriz and Hamadan, where they had been euthanized for reasons unrelated to gastrointestinal disorders. Additionally, specimens that had died due to road traffic accidents but possessed an intact, undamaged gastrointestinal tract were included. For all specimens, body weight and crown-rump length were measured and recorded.

For the anatomical studies, the thoracic cavity was opened by removing the ribs, and a cannula was inserted into the thoracic aorta in the direction of the abdomen. Red-colored latex was then injected into the thoracic aorta via the cannula. Following the injection, the specimens were transferred into 10% formalin for preservation. After 7 days, the abdominal cavity was dissected, and the branching patterns of the celiac trunk, cranial mesenteric artery, and caudal mesenteric artery from the aorta, as well as their distribution to various parts of the gastrointestinal tract, were evaluated using both the naked eye and a stereomicroscope. Finally, digital photographs of the vascular branches were captured using a digital camera. The distance between the branches and the length of each vessel were subsequently measured using a digital caliper. Ultimately, schematic diagrams representing the branching patterns of all evaluated vessels were generated using Microsoft Visio 2019 software.

To conduct the radiological study, the thoracic cavity was first opened by removing the ribs, and a cannula was placed inside the thoracic aorta toward the posterior aspect of the animal. Then, barium sulfate (manufactured by PharmaChemi Pharmaceutical Company) was injected into the thoracic aorta, and dorsoventral as well as lateral radiographic images of the cat's thoracic region were obtained using a SMAM srl Via tiziano24 radiology device. The obtained images were examined, and the abdominal vessels were named according to anatomical reference data. At the end of the procedure, a t-test was used to confirm the statistical significance of the results. A p-value of less than 0.05 was considered statistically significant ($p < 0.05$).

Results

For ease of understanding and comparison, the findings are described based on the natural sequence of blood flow, moving from the cranial to the caudal regions of the abdominal aorta. In addition to the qualitative dissection of the course and branching patterns, quantitative indices such as the length of the main branches and their vertebral alignment at the point of origin were measured and recorded to provide a more precise overview of the vascular status in this region. In the following sections, the general branching pattern of the abdominal aorta is described first, followed by the specific characteristics of each of its main branches, including the celiac trunk and the cranial and caudal mesenteric arteries.

Branching Patterns of the Abdominal Aorta in the Studied Specimens

In all examined specimens, a relatively uniform and consistent branching pattern of the abdominal aorta was observed; upon entering the abdominal cavity, the visceral and parietal branches originated in a regular and predictable sequence. This finding might be attributed to either the limited statistical power resulting from a small sample size or the genetic homogeneity of the breed across the samples, as nearly all subjects were of the Domestic Shorthair (DSH) type. The first branch to arise from the abdominal aorta was the celiac trunk, and immediately distal to it, the cranial mesenteric artery originated from the ventral surface of the aorta. Further along its course, the right and left adrenal arteries, the right and left renal arteries, and the right and left ovarian arteries in females or testicular arteries in males originated sequentially from the abdominal aorta. Following these vessels, the caudal mesenteric artery was observed as a single branch. In the terminal segment of the abdominal aorta, the left and right deep circumflex iliac arteries, the left and right external iliac arteries, the right and left internal iliac arteries, and finally, the median sacral artery originated in succession. This anatomical sequence was consistently repeated in all 20 specimens, and no distinct deviations from this pattern—such as the absence of a specific branch or the presence of an unusual accessory branch—were observed. Therefore, this sequence can be introduced as the predominant branching pattern of the abdominal aorta in the domestic cat. The general structure of the abdominal aorta and its branching pattern are illustrated schematically and in a dissected specimen in Figures 1 and 2, respectively.

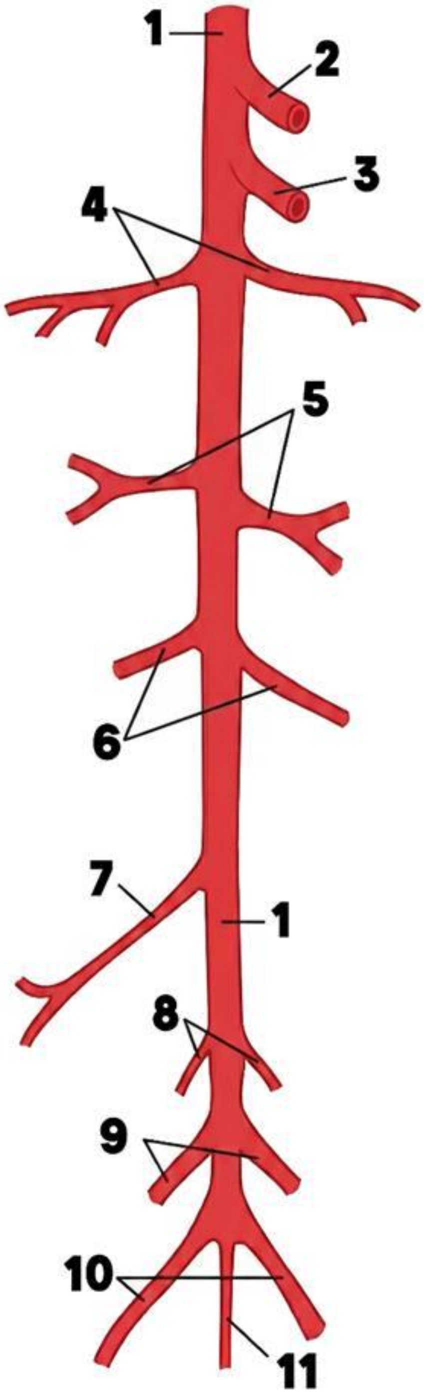

Figure 1. Branching pattern of the abdominal aorta. 1. Abdominal aorta, 2. Celiac artery, 3. Cranial mesenteric artery, 4. Phrenicoabdominal arteries, 5. Renal arteries, 6. Testicular or ovarian arteries, 7. Caudal mesenteric artery, 8. Deep circumflex iliac arteries, 9. External iliac arteries, 10. Internal iliac arteries, 11. Median sacral artery.

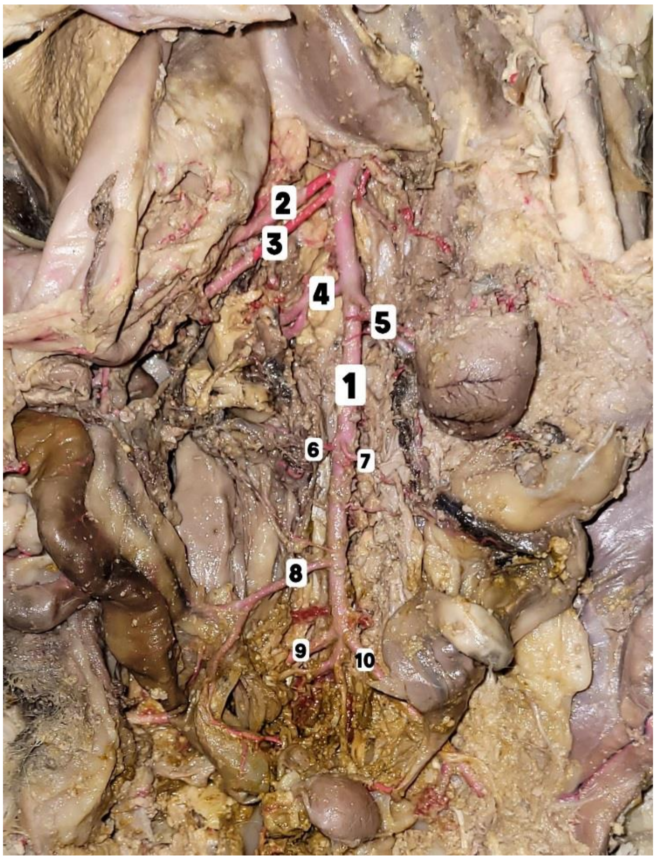

Figure 2. Branching pattern of the abdominal aorta. 1. Abdominal aorta, 2. Celiac artery, 3. Cranial mesenteric artery, 4. Right renal artery, 5. Left renal artery, 6. Right ovarian arteries, 7. Left ovarian artery, 8. Caudal mesenteric artery, 9 and 10. External iliac arteries.

Celiac Trunk

The celiac trunk is the first major visceral branch of the abdominal aorta in the domestic cat, which originates from its ventral surface immediately after the aorta enters the abdominal cavity and courses cranio-dextrally. This artery exhibited a consistent trifurcation pattern in all studied specimens; after a short course, the celiac trunk divided into three main branches: the hepatic, left gastric, and splenic arteries. The first branch was the hepatic artery, which coursed in a relatively straight path toward the hepatic lobes, supplying the liver while also sending branches to the vicinity of the stomach and the proximal duodenum. The second branch, the left gastric artery, was primarily distributed along the lesser curvature of the stomach, supplying the upper regions of the stomach by emitting a branch to the gastric fundus and the terminal esophagus, while its other branch supplied the major portion of the lesser curvature. The third branch was the splenic artery, which, after giving off a branch to the left lobe of the pancreas, entered the splenic parenchyma and subsequently continued as multiple branches along the greater curvature of the stomach, supplying this region via the left gastroepiploic artery. Measurements revealed that the mean length of the celiac trunk across the 20 examined specimens was 17.43 ± 3.70 mm. Regarding the vertebral alignment, the origin of this artery from the abdominal aorta was located at the level of the first lumbar vertebra (L1) in 8 cases, between L1 and L2 in 8 cases, at the 13th thoracic vertebra (T13) in 3 cases, and between T13 and L1 in 1 case. Statistical analysis of the data demonstrated no significant correlation between the length of the celiac trunk and the crown-rump length of the cats, regardless of sex. The results concerning the vertebral level and the length of the celiac trunk and its main branches are summarized in Tables 1 and 2, and the dissection view of the branching of this artery is shown in Figure 3.

Cranial Mesenteric Artery

The cranial mesenteric artery is the second largest visceral branch of the abdominal aorta in the domestic cat. It originates from the ventral surface of the aorta distal to the celiac trunk and runs a relatively long course within the thickness of the mesentery toward the small intestines. In all examined specimens, this artery demonstrated a consistent pattern of primary branching, initially dividing into three main branches. The first branch entered the descending colon and was distributed along the mesocolon. The second branch entered the ascending duodenum, supplying this region as well as a portion of the mesenteric ileum. The third branch coursed toward and along the cecum; this branch anastomosed with the first (colic) branch, thereby forming a continuous vascular arch in the region of the descending colon and cecum. At the level of the origin of this third branch, a series of multiple branches arose to supply different segments of the jejunum, forming an extensive network of jejunal arteries.

The length of the cranial mesenteric artery, measured from its origin on the aorta to the point of its initial trifurcation, averaged 29.08 ± 4.14 mm across the 20 specimens. Regarding its vertebral position, this artery originated from the abdominal aorta at the level of the second lumbar vertebra (L2) in 13 cases, between L2 and L3 in 5 cases, and between L3 and L4 in 2 cases. Statistical analysis indicated no significant correlation between the length of the cranial mesenteric artery and the crown-rump length of the studied cats, independent of sex. On average, between 11 and 14 jejunal branches were identifiable in each specimen, demonstrating the substantial extent of the jejunal vascular network in the domestic cat. Table 3 shows the distribution of the vertebral levels of origin for the cranial mesenteric artery, and Figures 4 and 5 display the dissection views of the branches of this artery and the jejunal branches, respectively.

Caudal Mesenteric Artery

In all specimens evaluated in this study, the caudal mesenteric artery originated as a single branch from the

Table 1. The level at which the celiac artery branches from the aorta.

Number of the vertebra	Number of specimens
L1	8
T13	3
T13-L1	1
L1-L2	8

Table 2. The level at which the cranial mesenteric artery branches from the aorta.

Number of the vertebra	Number of specimens
L2	13
L2-L3	5
L3-L4	2

Table 3. The level at which the caudal mesenteric artery branches from the aorta.

Number of the vertebra	Number of specimens
L5-L6	3
L6	11
L6-L7	4
L7	2

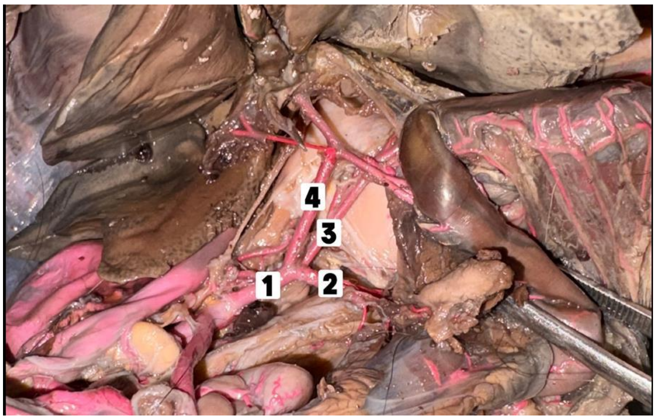

Figure 3. Branches of the celiac artery. Ventral aspect. 1. Celiac trunk, 2. Splenic artery, 3. Left gastric artery, 4. Hepatic artery.

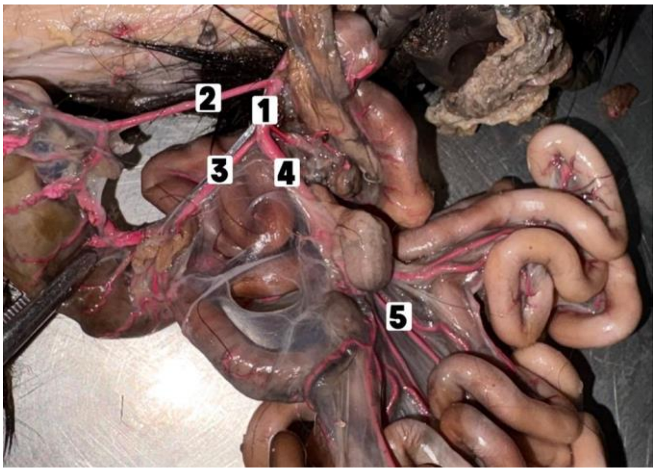

Figure 4. The cranial mesenteric artery (1) and its jejunal branches (2, 3, 4, and 5).

Figure 5. Jejunal arteries.

ventro-caudal surface of the abdominal aorta. This artery ran a relatively short course before dividing into its two main terminal branches: the left colic artery and the cranial rectal artery, which supplied the descending colon and the proximal rectum, respectively. The left colic artery coursed along the mesenteric border of the descending colon, emitting branches to supply this region, while the cranial rectal artery advanced deep within the mesorectum to supply the proximal segments of the rectum, thereby playing a crucial role in maintaining blood flow to the terminal part of the gastrointestinal tract. The mean length of the caudal mesenteric artery across the 20 examined specimens was measured to be 25.45 ± 3.33 mm. Regarding the vertebral alignment, the origin of this artery was located between the fifth and sixth lumbar vertebrae (L5–L6) in 3 cases, at the level of the sixth lumbar vertebra (L6) in 11 cases, between L6 and L7 in 4 cases, and at the level of the seventh lumbar vertebra (L7) in 2 cases. Data analysis revealed that, similar to the cranial mesenteric artery, no significant correlation was observed between the length of the caudal mesenteric artery and the crown-rump length of the animals, regardless of sex. The dissection view of the caudal mesenteric artery and its relationship with the terminal branches of the abdominal aorta is presented in Figure 6. The topographic positioning of the abdominal arteries is illustrated in angiographic Figure 7.

Discussion

The present study investigated the branching patterns and morphometric characteristics of the celiac artery, cranial mesenteric artery, and caudal mesenteric artery in 20 domestic short-haired cats. The celiac artery was observed as a single vessel with a constant trifurcation pattern into hepatic, left gastric, and splenic branches in all specimens. This finding is in complete agreement with the report by Pommellet *et al*. (2018), who described the trifurcation pattern as common in cats and dogs,[15] as well as the study by Xavier-Silva *et al*. (2013), who reported trifurcation in 100% of their female cats.[16] However, comparison with the results of Abidu-Figueiredo *et al*. (2005) in dogs shows that the bifurcation pattern (gastrosplenic trunk) is more prevalent in dogs (56.7%) than the trifurcation pattern (33.3%), indicating a species-specific difference and suggesting that the vascular pattern in domestic cats is more uniform.[17] Regarding the celiacomesenteric trunk (CMT) as a congenital anomaly, we did not observe this condition in any of our specimens. This finding differs from the report by Estruc *et al*. (2012), who reported a prevalence of 16.66% in male cats and 7.14% in female cats,[18] as well as the study by Gorissen *et al*. (2014), who described it as a rare finding in cats.[19] Although the absence of this anomaly in the present study may be due to the limited sample size (n = 20), it suggests that the independent

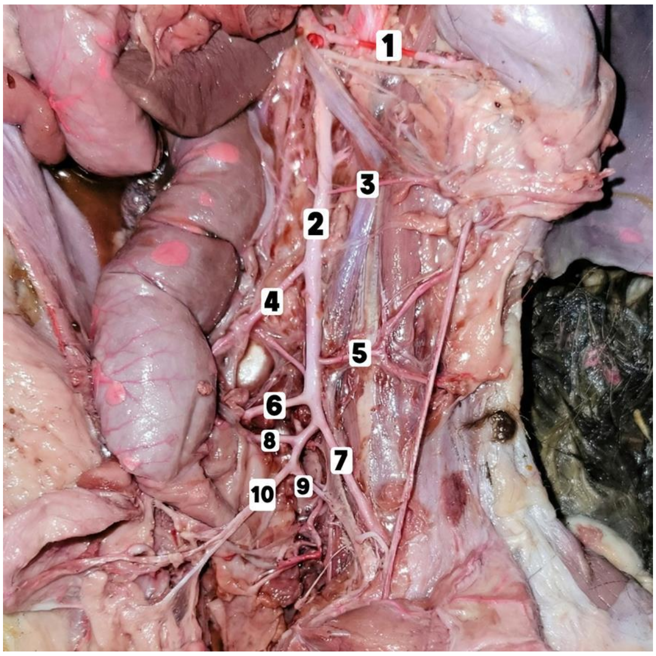

Figure 6. The terminal branches of the abdominal aorta. 1. Left renal artery, 2. Abdominal aorta, 3. Left testicular artery, 4. Caudal mesenteric artery, 5. Left deep circumflex iliac artery, 6. Right external iliac artery, 7. Left external iliac artery, 8. Right internal iliac artery, 9. Left internal iliac artery, 10. Vesical artery.

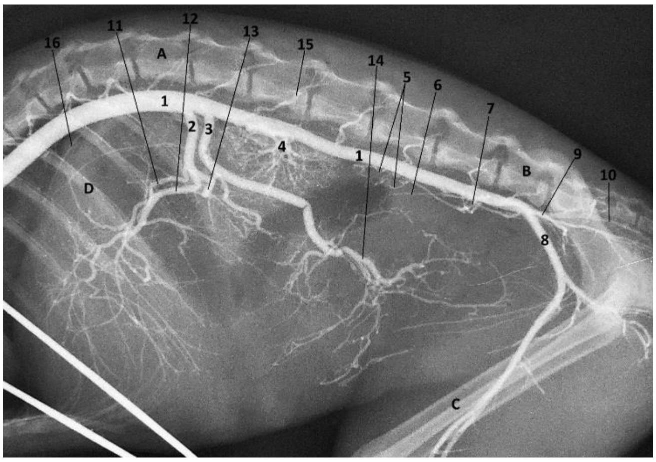

Figure 7. Lateral view of an abdominal angiography of a cat. *Osseus structures*; A. First lumbar vertebra, B. Seventh lumbar vertebra, C. Femurs, D. Tenth pair of ribs, *Arteries*; 1. Abdominal aorta, 2. Celiac trunk, 3. Cranial mesenteric artery, 4. Renal arteries, 5. Ovarian arteries, 6. Caudal mesenteric artery (left colic branch), 7. Deep circumflex iliac arteries, 8. External iliac arteries superimposed on one another, 9. Internal iliac arteries, 10. Median sacral artery, 11. Splenic artery, 12. Hepatic artery, 13. Left gastric artery, 14. Jejunal arteries, 15. Lumbar artery, 16. Cranial phrenic artery.

separation of the celiac and cranial mesenteric arteries from the abdominal aorta is the dominant and normal pattern in our study population. Regarding vertebral level, the celiac artery originated at the level of the first lumbar vertebra in 40% of specimens, between the first and second lumbar vertebrae in 40%, and at the level of the 13th thoracic vertebra in 15%. This variability is consistent with the study by Dennis (2005) on 100 dogs and cats, who reported that 71% of celiac arteries originated ventral to L1 and found no clear relationship between vessel position and breed, sex, age, or body weight, emphasizing that these vessels cannot be used as precise anatomical landmarks for determining the location of spinal cord lesions.[20] Furthermore, no significant correlation was observed between the mean length of the celiac artery and the crown-rump length of the animals, which is completely consistent with the findings of Abidu-Figueiredo *et al*. (2005) in dogsand Xavier-Silva *et al*. (2013) in cats.[16,17]

The cranial mesenteric artery, as the second largest visceral branch of the abdominal aorta, originated from its ventral surface after the celiac artery in all specimens and demonstrated a relatively consistent initial branching pattern comprising three main branches directed toward the descending colon, the ascending duodenum, and the cecum, respectively. The observed branching pattern closely resembles the report by Silva *et al*. (2008) in the opossum, who described the posterior pancreaticoduodenal, middle colic, right colic, jejunal, and ileocolic arteries.[21] Similarly, the study by Estruc *et al*. (2012) in domestic cats reported comparable branches, including the caudal pancreaticoduodenal artery, middle and right colic arteries, jejunal arteries, and ileocecocolic arteries, which is consistent with our findings.[18] Regarding the vertebral level, the cranial mesenteric artery originated at the level of the second lumbar vertebra in 65% of our specimens, which is comparable to the study by Culp *et al*. (2015) in dogs, who reported the origin at the cranial half of L2 or the L1-L2 intervertebral disc space.[22] However, we observed the origin of this artery between the third and fourth lumbar vertebrae in 2 out of 20 specimens (10%), indicating a wider range of variation than previously reported. Similar to the celiac artery, no significant correlation was found between the mean length of the cranial mesenteric artery and crown-rump length. This finding is completely consistent with the results of Estruc *et al*. (2012) in cats and Estruc *et al*. (2015) in rabbits, who reported no relationship between cranial mesenteric artery length and rostro-sacral length.[18,23] The mean number of jejunal branches in our study ranged from 11 to 14 per specimen. This range is in close agreement with the results of Culp *et al*. (2015) in dogs (8 to 13 branches) and Silva *et al*. (2008) in opossums (6 to 15 branches) but is lower than that reported by Estruc *et al*. (2015) in rabbits (17 to 18 branches), a difference likely attributable to interspecific anatomical variations and differences in small intestinal length.[18,21,22] Additionally, the study by Bahgat (2007) in the red fox reported eight jejunal arteries and three to four ileal arteries,[24] suggesting that the number of jejunal branches in domestic cats is higher than in foxes but lower than in rabbits.

The caudal mesenteric artery originated as a single branch from the ventral-caudal surface of the aorta in all 20 specimens and divided into two main branches: the left colic artery and the cranial rectal artery. This bifurcation pattern observed in domestic cats is in complete agreement with the reports of most researchers, including Silva *et al*. (2008) in the opossum, Bahgat (2007) in the red fox, Mohamed *et al*. (2017) in sheep, and Flešárová and Maženský (2018) in the European brown hare.[21,24-26] However, the study by Estruc *et al*. (2012) in domestic cats reported the absence of the caudal mesenteric artery in 7.14% of female cats and 11.11% of male cats,[18] whereas we observed this artery clearly and identifiably in all 20 specimens (100%). This difference may be related to population, breed, or geographical variations in the specimens. Regarding vertebral level, the caudal mesenteric artery originated at the level of the sixth lumbar vertebra in 55% of our specimens, between the sixth and seventh lumbar vertebrae in 20%, and between the fifth and sixth lumbar vertebrae in 15%. This finding is similar to the study by Bahgat (2007) in the fox, which reported the position of this artery opposite the posterior border of the transverse process of the sixth lumbar vertebra.[24] Furthermore, no significant correlation was observed between the length of this artery and crown-rump length. This finding is consistent with the results of Estruc *et al*. (2012) in cats and Estruc *et al*. (2015) in rabbits,[18,23] reinforcing the conclusion that the length of the visceral branches of the abdominal aorta is an individual characteristic independent of animal size.

Taking a comprehensive view of the findings of this study and comparing them with other research, although the overall branching pattern of the abdominal aorta in domestic cats is relatively uniform, individual variations, particularly in the vertebral level of origin and the length of the arteries, are considerable. The study by Kigata *et al*. (2025) in the common marmoset demonstrated that the celiac artery can occasionally give rise to the middle colic artery or jejunal arteries;[27] however, such variation was not observed in our study, indicating specific differences between rodents and carnivores. Furthermore, the study by Flešárová and Maženský (2018) in rabbits showed that the variability in the branching pattern of the celiac artery was greater than that of the cranial and caudal mesenteric arteries,[26] whereas in our study, the cranial mesenteric artery exhibited greater variation in its vertebral level of origin. Clinically, the emphasis by Dennis (2005) on the absence of a clear relationship between vessel position and breed, sex, age, or body weight is confirmed by our findings,[20] underscoring the importance of performing patient-specific angiographic evaluations prior to complex abdominal surgeries. Finally, the complete concordance of our findings with several independent studies regarding the lack of correlation between the length of visceral arteries and body size (crown-rump length) provides a strong conclusion that the length of these arteries is an individual trait and cannot be estimated based on animal size. This finding is important for veterinary surgeons, as it indicates that during surgery, the length of arteries should not be predicted based on the animal's apparent size, and individual variations should be anticipated.

Conflict of Interest

The authors declare no conflict of interest regarding this manuscript.

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