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Main Branches of the Aortic Arch in *Leopardus pardalis* (Carnivora: Felidae): Anatomical Description In Two Specimens

Ramos Principais do Arco Aórtico em Leopardus pardalis (Carnivora: Felidae): Descrição Anatômica em Dois Espécimes

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Abstract

The ocelot (*Leopardus pardalis*) is a medium-sized spotted Neotropical felid that is currently distributed from southern Texas (USA), throughout Central America and the Amazon, to northern Argentina. In the present research, 02 specimens of adult female ocelots were used. After fixation with a 10% formaldehyde solution and filling the arterial system with a colored latex solution according to standard anatomical technique, dissection was carried out to observe the arrangement of the collateral branches of the aortic arch. The aortic arch presented a curvature to the left, giving off two branches, the brachiocephalic trunk and the left subclavian artery. The left subclavian artery gave rise to the following branches: the vertebral artery, the left internal thoracic artery, the costocervical trunk and the superficial cervical artery. The trunk gave rise to the left carotid artery, right carotid artery, right internal thoracic artery, costocervical trunk, vertebral artery, right subclavian artery and superficial cervical artery. The ocelots aortic arch fits type II.

Keywords: Anatomy. Aorta. Feline.

Resumo

A jaguatirica (*Leopardus pardalis*) é um felino neotropical de porte médio e pelagem manchada, cuja distribuição atual se estende desde o sul do Texas (EUA), por toda a América Central e Amazónia, até ao norte da Argentina. Na presente pesquisa foram utilizados 02 espécimes de jaguatiricas adultas do sexo feminino. Após fixação com solução de formaldeído a 10%, e preenchimento do sistema arterial com solução de látex corado conforme técnica anatômica padrão, procedeu- se à dissecção para observação da disposição dos ramos colaterais do arco aórtico. O arco aórtico apresentou-se com uma curvatura à esquerda, emitiu dois ramos, o tronco braquiocefálico e a artéria subclávia esquerda. A artéria subclávia esquerda originou os seguintes ramos: a artéria vertebral, a artéria torácica interna esquerda, o tronco costocervical e a artéria cervical superficial. O tronco deu origem a artéria carótida esquerda, artéria carótida direita, artéria torácica interna direita, tronco costocervical, artéria vertebral, artéria subclávia direita e artéria cervical superficial. O arco aórtico da jaguatirica se enquadra no tipo II.

Palavras-chave: Anatomia. Aorta. Felino.

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1 Introduction

The ocelot (*Leopardus pardalis*) is a medium-sized spotted Neotropical felid that is currently distributed from southern Texas (USA), throughout Central America and the Amazon, to northern Argentina. During the 1960s and 1970s, ocelots were heavily hunted for the fur trade, causing drastic declines in abundance throughout their range (Sunquist; Sunquist 2002). Once, considered vulnerable on the IUCN Red List, the ocelot is now a species of least concern (Caso *et al*., 2008; Oliveira *et al.*, 2013) due to bans on the international fur trade.

Today, habitat loss continues to threaten its existence, but population data for this species are scarce. Although, the Brazilian Amazon constitutes about half of the ocelot's range, ecological information on the species in the region is limited and there are no population estimates for ocelots in this region. Ocelots are terrestrial, primarily nocturnal and solitary animals that exhibit a high degree of habitat plasticity, occurring in dense forests, open savannas (Brazilian Cerrado), the Pantanal, and even in the semi-arid Caatinga (Trolle *et al*., 2003).

The curvature of the aortae after leaving the left ventricle of the heart is called arcus aortae. (Goshal, 1981). The head, neck, forelimbs, some organs in the thoracic cavity, and the ventral part of the chest are supplied by two large vessels, the arteria subclavia and arteria carotis communis, which originate from the arcus aortae (Ahn *et al.*, 2010). In carnivores the arteria subclavia sinistra originates directly from the arcus aortae, not from the truncus brachiocephalic (Chiasson; Booth 1982).

Morphological studies of wild felids are important because they contribute to the understanding of the ecological characteristics of a species. In addition, anatomy, one of the oldest biomedical sciences, is a key tool for addressing questions related to the biology and evolution of species, especially with regard to interactions with the environment, feeding, and reproductive adaptations (Stocco *et al.*, 2025).

Despite the increase in basic and applied research involving wild animals, anatomical studies describing vascular anatomy in these species are scarce. However, with regard to morphology, a small number of studies on these species have shown that it is crucial to obtain anatomical information both for future work and for the preservation of the species in captivity or in natural habitats. This study aims to describe the morphology and main branches of the aortic arch in *Leopardus pardalis*.

2 Material and Methods

The article derives from the project "Basic and Applied Research in the Morphology of Wild and Exotic Animals," which was submitted and approved by the Ethics Committee on Animal Use (CEUA) (No. 018/2017).

During dissection activities carried out at the Laboratory of Teaching and Research in Morphology of Domestic and Wild Animals (LEPeMADS) of the Department of Animal and Human Anatomy at the Federal Rural University of Rio de Janeiro, the morphology of the aortic arch was observed in 02 specimens of ocelot, adult females, donated by Serra dos Órgãos National Park to LEPeMADS.

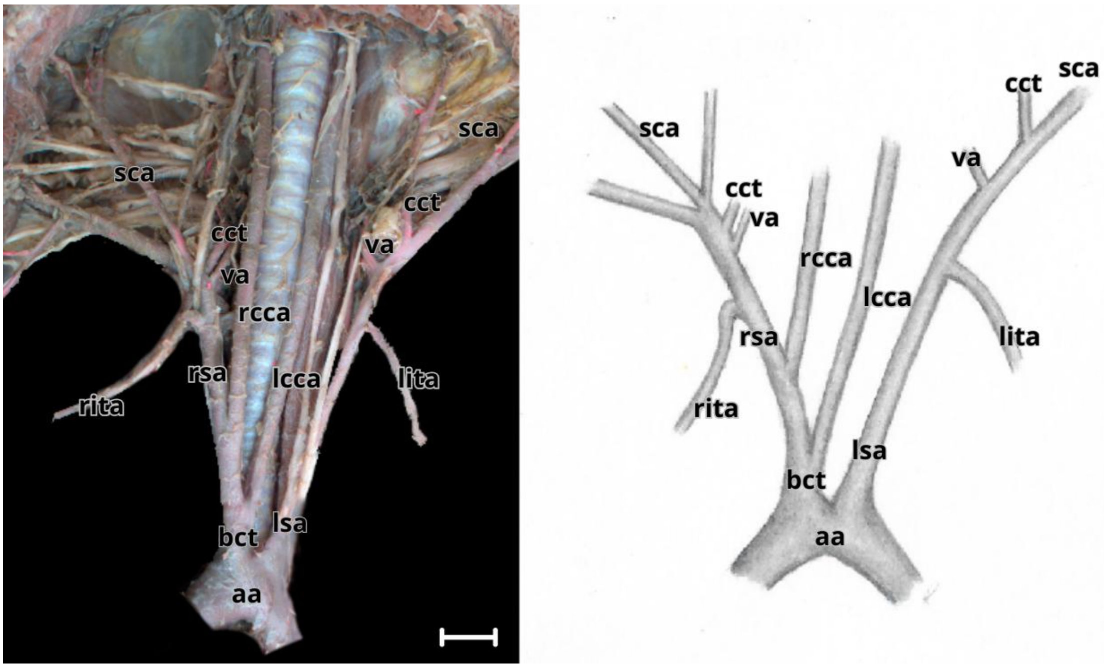
The animals did not present any macroscopic alterations. The cadavers were identified and positioned in right lateral recumbency. Next, the thorax was opened and dissected to expose the thoracic aorta, into which a number 6 urethral probe was introduced. In this way, the arterial system was “washed” with 0.9% NaCl physiological solution and then fixed with a 10% formalin solution. Afterwards, an aqueous solution (1:1 dilution) of Petrolátex S-65 (Duque de Caxias Refinery REDUC of Petrobrás, Duque de Caxias-RJ) mixed with dye (Suvinil xadrez®) was injected through the probe. Subsequently, the cadavers were immersed in a low-density polyethylene box with a capacity of 50 liters containing a 10% formalin solution to complete the fixation and latex polymerization process. Seven days after the latex injection, the specimens were washed in running water, and the thoracic cavity was opened and dissected to observe the distribution of the arteries of the aortic arch. All adopted nomenclature was based on the Veterinary Gross Anatomical Nomenclature (International Committee on Veterinary Gross Anatomical Nomenclature, 2017). Photomacrographs were taken using a Nikon DSLR camera, model D5200, 16 MP, and an 18–55 mm lens. Schematic drawings were also made.

3 Results and Discussion

3.1 Animal 01

Young adult female, measuring 62 cm in rostro-sacral length. The aortic arch of the ocelot presented a curvature to the left and emitted two branches: the brachiocephalic trunk and the left subclavian artery. The left subclavian artery originated from the aortic arch, below the level of origin of the brachiocephalic trunk, passing obliquely to the left along the ventral surface of the esophagus. The left subclavian artery gave rise to the following branches: the vertebral artery, the left internal thoracic artery, the costocervical trunk, and the superficial cervical artery. The brachiocephalic trunk gave rise to the left common carotid artery and to a new trunk originating the right common carotid artery and the right subclavian artery. The right subclavian artery gave rise to the right internal thoracic artery, costocervical trunk, vertebral artery, and superficial cervical artery (Figure 1). The length of the brachiocephalic trunk was 1.0 cm.

Figure 1 - Digital photomacrograph showing the aortic arch and its collateral branches. aa: aortic arch; lsa: left subclavian artery; lita: left internal thoracic artery; bct: brachiocephalic trunk; lcca: left common carotid artery; rcca: right common carotid artery; rsa: right subclavian artery; rita: right internal thoracic artery; va: vertebral artery; cct: costocervical trunk; sca: superficial cervical artery. Scale bar: 1 cm

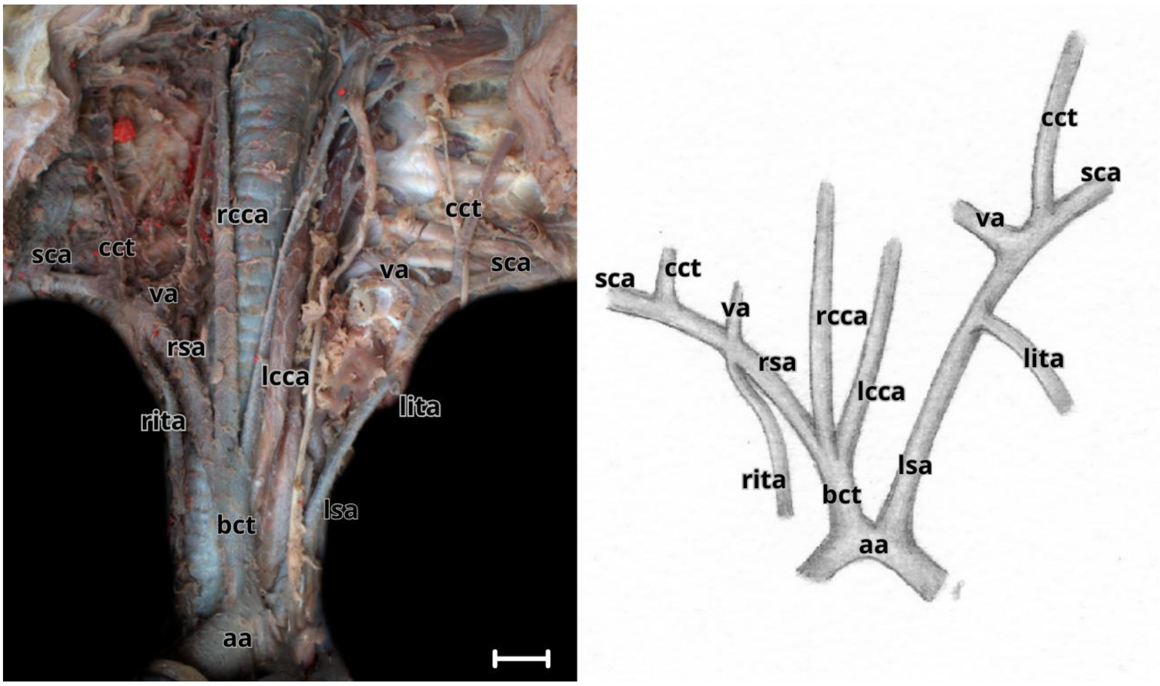


Source: the authors.

3.2 Animal 02

Young adult female, measuring 64 cm in rostro-sacral length. The aortic arch emitted two branches: the brachiocephalic trunk and the left subclavian artery. The left subclavian artery originated from the aortic arch, below the level of origin of the brachiocephalic trunk, passing obliquely to the left along the ventral surface of the esophagus. The left subclavian artery gave rise to the following branches: the vertebral artery, the left internal thoracic artery, the costocervical trunk, and the superficial cervical artery. The brachiocephalic trunk gave rise to the right and left common carotid arteries as well as the right subclavian artery. The right subclavian artery gave rise to the right internal thoracic artery, the costocervical trunk, the vertebral artery, the right subclavian artery, and the superficial cervical artery (Figure 2). The length of the brachiocephalic trunk was 2.6 cm.

Figure 2 - Digital photomacrograph showing the aortic arch and its collateral branches. aa: aortic arch; lsa: left subclavian artery; lita: left internal thoracic artery; bct: brachiocephalic trunk; lcca: left common carotid artery; rcca: right common carotid artery; rsa: right subclavian artery; rita: right internal thoracic artery; va: vertebral artery; cct: costocervical trunk; sca: superficial cervical artery. Scale bar: 1 cm



Source: the authors.

Collateral branches of the aortic arch have been described in different species of domestic mammals and in some wild mammals, characterizing the main arteries that emerge directly from the arch, their respective branches, and thus proposing a classification.

The first type, or type I, corresponds to only the brachiocephalic trunk arising from the aortic arch, and from it emerge the right and left common carotid arteries and the right and left subclavian arteries, observed inbuffalo (Cortellini *et al*., 2000), capybara (Culau *et al*., 2007), and gray brocket deer (Schimming *et al*., 2012).

The second type, or Type II, identified in both dissected specimens, was characterized by the presence of two branches originating from the aortic arch: the brachiocephalic trunk and the left subclavian artery. The brachiocephalic trunk gave rise to the right and left common carotid arteries as well as the right subclavian artery. It has been observed in the paca (*Cuniculus paca*) (Oliveira *et al.*, 2001), chinchilla (*Chinchilla lanigera*) (Araujo *et al*., 2004), guinea pig (*Cavia porcellus*) (Kabak; Haziroglu 2003), rock cavy (*Kerodon rupestris*) (Magalhães *et al.*, 2007), coypu (*Myocastor coypus*) (Campos; Araújo; Azambuja 2010), spix's Yellow-toothed Cavy (*Galea spixii*) (Oliveira *et al.*, 2015), Eurasian otter (*Lutra lutra*) (Jang *et al.,* 2023), badger (*Meles meles*) (Haligür; Özkadif, 2023), and in raccoon dogs (*Nyctereutes procyonoides*) (Lee *et al*., 2024).

In the third type, or type III, three collateral arteries arise from the aortic arch: the brachiocephalic trunk, the left common carotid artery, and the left subclavian artery; from the brachiocephalic trunk emerge the right common carotid and right subclavian arteries. This vascular pattern has been described in the West Indian manatee (Rowlatt; Marsh 1985), mouse (Casteleyn *et al.*, 2010), and black-handed tamarin (Branco *et al*., 2017).

The arcus aortae branching pattern varies among different animal species depending on the number of arteries branching from the arcus aortae. This variation is associated with thorax breadth (Ahn *et al.*, 2008; Parsons, 1902). For instance, animals with a laterally compressed thorax, such as ungulates Bovidae (Ghoshal, 1981), Equidae (Ghoshal, 1981), and Cervidae (Ahn *et al*., 2008) usually exhibit arcus aortae type I with only one artery: the brachiocephalic trunk. On the other hand, when the thorax is compressed in the dorsoventral (anteroposterior) direction, as in humans (Garis *et al.*, 1933) and rhesus monkeys (Garis, 1938), they exhibit a type III aortic arch, with three arteries: the brachiocephalic trunk, the left common carotid artery, and the left subclavian artery.

Most carnivores with an intermediate thorax breadth predominantly exhibit arcus aortae type II with two arteries: the brachiocephalic trunk and left subclavian artery. These animals include dogs (Ahn *et al.*, 2010), cats (More *et al*., 2016), lions (Parsons, 1902), Eurasian otters (Jang *et al.*, 2023), crab-eating fox (Lima *et al*., 2016), raccoons (Parsons, 1902), and tigers (Parsons, 1902). Although a Type II pattern was observed in the specimens dissected in the present study, the arrangement of the brachiocephalic trunk varied macroscopically, without differences in the number of arteries and branches. In certain marine carnivores such as gray seals (Parsons, 1902), deep-diving hooded seals (Drabek; Burns 2002), and ringed seals (Smodlaka *et al*., 2009) have been reported to exhibit arcus aortae type III. This suggests that marine habitats may influence branching patterns.

The morphological arrangement observed in the ocelot resembles that found in the dog and cat (Ahn *et al.*, 2010; More *et al.*, 2016) and in the red fox (*Vulpes vulpes*) (Karakurum; Özgel, 2013), in which there is no common trunk between the two common carotid arteries.

In Maine Coon cats, Khvatov *et al*. (2022) observed that the brachiocephalic artery and the left subclavian artery depart from the aortic arch. The type of division of the brachiocephalic artery is bifurcation; there is a division into the right subclavian artery and the trunk of the common carotid arteries. The right and left subclavian arteries successively give off branches: the vertebral artery, the internal thoracic, costocervical trunk.

According to Fernando Filho and Borelli (1970), in a study conducted with 240 cats, in 165 specimens (68.7%), the aortic arch gave rise to two branches: the brachiocephalic trunk and the left subclavian artery. In 75 cases (31.3%), the aortic arch also gave rise to the brachiocephalic trunk and the left subclavian artery. From the brachiocephalic trunk, the formation of the bicarotid trunk was observed.

In the ocelots dissected in the present study, the aortic arch presented a leftward curvature and gave rise to two branches: the brachiocephalic trunk and the left subclavian artery. According to Goshal (1981), in dogs, two branches arose from the aortic arch: the brachiocephalic trunk, which in most cases gave rise to the left common carotid artery, the right common carotid artery, and the right subclavian artery; and the second branch, the left subclavian artery. This arrangement was also observed in 50% of male and 40% of female rabbits (Valério *et al*., 2008), in the domestic cat (Fernando Filho; Borelli 1970; Zelenevsky *et al*. 2022), and in the red fox (*Vulpes vulpes*) (Karakurum; Özgel 2013).

In jaguarundi (*Herpailurus yagouaroundi*), Santo *et al.* (2025) observed that two specimens presented two branches originating from the aortic arch: the brachiocephalic trunk and the left subclavian artery. The brachiocephalic trunk first gave rise to the right subclavian artery and subsequently to the bicarotid trunk, which in turn gave rise to the right and left common carotid arteries. In a third specimen, the aortic arch gave rise to two branches: the bicarotid trunk, from which the right and left common carotid arteries originated, and a common trunk that gave rise to the right and left subclavian arteries.

Lee *et al.* (2024) observed that in raccoon dogs using silicone castings, all 35 animals showed arcus aortae with two arteries: the brachiocephalic trunk and left subclavian artery, branching from the arcus aortae. The same configuration was observed by Haligür and Özkadif (2023) in the arcus aortae in badger (*Meles meles*), in Eurasian Otter (*Lutra lutra*) (Jang *et al.*, 2023) and in the red fox (*Vulpes vulpes*) (Karakurum; Özgel 2013).

4 Conclusion

Although the sample size was limited, the results indicate that the branching pattern of the aortic arch in the examined ocelots falls within type II, corroborating the configuration observed in terrestrial carnivores. However, additional studies with a larger number of specimens are necessary to assess the extent of intraspecific variation and confirm the patterns observed in the present study.

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