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Kaposiform intramuscular hemangiosarcoma in a hoary fox (*Lycalopex vetulus*)[1]

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ABSTRACT.- Leal DS, Rocha DO, Bezerra GAO, Macêdo IL, Cerqueira LA, Costa DEV, Hirano LQL, Castro MB. **Kaposiform intramuscular hemangiosarcoma in a hoary fox (*Lycalopex vetulus*).** *Pesquisa Veterinária Brasileira 46:e07859, 2026.* Laboratório de Patologia e Perícia Veterinária, Faculdade de Agronomia e Medicina Veterinária, Universidade de Brasília, Campus Universitário Darcy Ribeiro, Brasília, DF, Brazil. E-mail: mbcastro@unb.br

Hemangiosarcoma (HSA) is a malignant vascular neoplasm commonly reported in domestic dogs but rarely described in wild canids. The hoary fox (*Lycalopex vetulus*), a near-threatened Neotropical canid endemic to the Brazilian Cerrado, has rarely been associated with neoplastic disease. This report describes the clinical, gross, histopathological, and immunohistochemical findings of a Kaposiform intramuscular HSA in a captive adult male hoary fox from Brazil. Clinically, the animal presented with moderate lameness and swelling of the left pelvic limb. Grossly, a poorly demarcated, infiltrative mass involved the proximal femoral musculature and showed irregular white, red, and black areas. Histologically, the neoplasm consisted of spindle-shaped cells arranged predominantly in solid sheets, with occasional irregular vascular channels, and was associated with marked pleomorphism and nineteen mitotic figures in 10 high-power microscopic fields (2.37 mm^2). Immunohistochemically, neoplastic cells were positive for CD31, Factor VIII, and vimentin. To our knowledge, this is the first report of Kaposiform intramuscular HSA in a Neotropical wild canid.

INDEX TERMS: Neoplasm, wild canids, immunohistochemistry, Neotropical canids, oncology.

RESUMO.- [**Hemangiossarcoma Kaposiforme intramuscular em uma raposa-do-campo (*Lycalopex vetulus*).**] O hemangiossarcoma (HSA) é uma neoplasia vascular maligna frequentemente descrita em cães domésticos, mas raramente em canídeos silvestres. A raposinha do campo (*Lycalopex vetulus*), um canídeo neotropical praticamente ameaçado e endêmico do Cerrado brasileiro, raramente tem sido associada a doenças neoplásicas. Este relato descreve os achados clínicos, macroscópicos, histopatológicos e imuno-histoquímicos de um HSA intramuscular do subtipo Kaposiforme em um macho adulto cativo de *L. vetulus* no Brasil. Clinicamente, o animal apresentava claudicação e aumento moderado de volume no membro pélvico esquerdo. Macroscopicamente, observou-se uma massa infiltrativa pouco delimitada envolvendo a musculatura femoral proximal, e apresentava áreas irregulares brancas, vermelhas e pretas. Histologicamente, a neoplasia era composta por células fusiformes, dispostas predominantemente em mantos sólidos, com canais vasculares irregulares ocasionais, associadas a acentuado pleomorfismo e dezenove figuras mitóticas em 10 campos de grande aumento microscópico (2,37 mm^2). No exame imuno-histoquímico, as células neoplásicas apresentaram imunomarcação positiva para CD31, fator VIII e vimentina. Até o momento, este é o primeiro relato de HSA intramuscular Kaposiforme em um canídeo silvestre Neotropical.

TERMOS DE INDEXAÇÃO: Neoplasia, canídeos selvagens, imunohistoquímica, canídeos Neotropicais, oncologia.

INTRODUCTION

Neoplasms have been reported sporadically in wild canids, typically affecting aged, captive individuals (Acton et al. 2000, Lamglait et al. 2015). In contrast, in a study of more than 100,000 domestic dog tissue samples submitted for histopathology in Germany, neoplasms accounted for 64.7%

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of diagnoses (Aupperle-Lellbach et al. 2022). The hoary fox (*Lycalopex vetulus*) is a near-threatened Neotropical wild canid (Lemos et al. 2020) from the Brazilian Cerrado (Brazilian Savannah). Neoplasms are rarely reported in this species, with one described case of a metastatic oral carcinoma in a female (Zanoti et al. 2024).

Hemangiosarcomas (HSA) are malignant neoplasms arising from vascular endothelial cells, characterized by highly infiltrative behavior and marked metastatic potential (Roccabianca et al. 2020, Suzuki et al. 2024). In domestic dogs, these neoplasms most frequently involve the spleen, liver, heart, and skin (De Nardi et al. 2023), although musculoskeletal presentations have also been reported (Carloni et al. 2019). However, the occurrence, anatomical distribution, and biological behavior of HSA remain poorly documented in wild canids (Newell-Fugate & Lane 2009, Lamglait et al. 2015, Sarvi et al. 2024, Sato et al. 2024).

Epidemiological data from domestic animals show a substantially higher frequency of neoplasms diagnosed by necropsy and biopsy than that reported in wildlife studies. In a series of 12,118 domestic animal specimens submitted for pathological evaluation, 16% were diagnosed with neoplastic lesions, predominantly in dogs (Kimura et al. 2012). This contrasts with the 2.75% prevalence of neoplasms reported in captive wild mammals at the San Diego Zoo (Effron et al. 1977).

Neoplasms are a significant cause of morbidity and mortality in domestic dogs, particularly in geriatric animals, with HSA accounting for approximately 5% of primary non-cutaneous malignant neoplasms in dogs (Griffin et al. 2021). In contrast, information on neoplastic diseases in wild canids remains scarce and is derived primarily from retrospective studies of captive animals in zoological collections. Although several neoplasms have been described in African wild dogs (*Lycaon pictus*), including carcinomas, soft tissue sarcomas, mammary and uterine tumors, and cutaneous apocrine neoplasms, reports of HSA remain rare (Lamglait et al. 2015, Mitchell et al. 2023). Similarly, in Neotropical canids, such as the maned wolf (*Chrysocyon brachyurus*), the most frequently reported neoplasms include ovarian dysgerminomas and mammary carcinomas, as well as a rare case of metastatic oral squamous cell carcinoma in a hoary fox (Marcinczyk et al. 2024, Zanoti et al. 2024). Furthermore, unspecified musculoskeletal sarcomas have been reported in a survey of 171 captive maned wolves in zoological collections (Marcinczyk et al. 2024).

Given the limited understanding of neoplasms in Neotropical wild canids, documenting and characterizing underreported neoplasms in wildlife species can elucidate causes of morbidity and contribute to conservation medicine for these species. Herein, we describe a case of Kaposiform intramuscular hemangiosarcoma in a captive hoary fox (*L. vetulus*), highlighting the clinical, gross, histopathological, and immunohistochemical findings.

MATERIALS AND METHODS

Ethical approval. In this study, the only material analyzed was tissue samples submitted for routine pathological evaluation. Therefore, no animal experiments were conducted, and ethical approval was not required under the guidelines of the National Council for the Control of Animal Experimentation (CONCEA). According to the clinical history report, an adult male hory fox (*Lycalopex vetulus*) weighing 4.5 kg from the "Fundação Jardim Zoológico de Brasília" (Brasília Zoological Garden Foundation), Brazil, presented with moderate lameness of the left pelvic limb and swelling in the proximal femoral region. A fine-needle aspiration biopsy was performed, and the cytological diagnosis was suggestive of a malignant spindle cell neoplasm. The animal underwent amputation of the left pelvic limb via coxofemoral disarticulation, and the specimen was sent for pathological evaluation to the "Laboratório de Patologia e Perícia Veterinária" (Veterinary Pathology and Forensic Laboratory) of the "Universidade de Brasília" (UnB), Brazil.

The amputated limb was received with intact, haired skin and showed marked enlargement of the proximal femoral region (Fig. 1). Tissue samples were collected, fixed in 10% neutral-buffered formalin, routinely processed, and stained with hematoxylin and eosin (HE) for histological examination.

Additionally, tumor tissue samples were submitted for immunohistochemical analysis using the biotin–streptavidin-peroxidase method with 3,3′-diaminobenzidine (DAB), 4 min (ImmunoDetector DAB, HRP, BioSB Inc.). Antibodies against Factor VIII (dilution 1:400, Factor VIII; clone F8/86, Dako Corp.), CD31 (dilution 1:100, CD31, clone JC/70A, Dako Corp.), and vimentin (dilution 1:400, VIM, clone Vim 3B4, Dako Corp.) were applied to histological sections after antigen retrieval in a pressure cooker, followed by an overnight incubation. Positive controls included a case of cutaneous canine hemangiosarcoma. Negative controls were incubated with normal rabbit serum (1:10 dilution) instead of the primary antibodies.

RESULTS

Gross findings included a heterogeneous, firm mass measuring 5.9 × 4.4 × 3.4 cm, with irregular white, red, and black areas. The mass expanded and infiltrated the tensor fasciae latae, vastus lateralis, semitendinosus, and semimembranosus muscles (Fig. 1).

Microscopically, skeletal muscle bundles were infiltrated by a spindle cell proliferation arranged in solid bundles and occasionally forming irregular vascular spaces (Fig. 2). The neoplastic cells had indistinct cell borders and eosinophilic



Fig. 1. Kaposiform intramuscular hemangiosarcoma, hory fox (*Lycalopex vetulus*). Gross aspect. Amputated limb with an intact, marked swelling of the proximal femoral region. Inset: Cut surface. Heterogeneous mass with irregular white, red, and black areas infiltrating muscle tissues.

cytoplasm (Fig. 3). The nuclei were oval, with coarse chromatin and one to two prominent nucleoli. Nineteen mitotic figures were observed in 10 high-power microscopic fields (2.37 mm^2). Extensive areas of necrosis, hemorrhage, and edema were interspersed within the neoplastic proliferation.

Neoplastic cells showed moderate immunolabeling for Factor VIII (Fig. 4), marked immunostaining for CD31 (Fig. 5), and VIM. Based on histopathological and immunohistochemical findings, the neoplasm was classified as a Kaposiform intramuscular HSA, exhibiting morphological features consistent with those described for this subtype in canine HSAs (Roccabianca et al. 2020, Suzuki et al. 2024).

DISCUSSION

Vascular neoplasms, particularly hemangiosarcomas (HSAs), are rarely reported in wild canids from the Northern Hemisphere and Africa, with sporadic cases involving visceral organs such as the right atrium, spleen, and liver (Newell-Fugate & Lane 2009, Sarvi et al. 2024). To date, only one metastatic case involving the thoracic musculature has been described in a red wolf (*Canis rufus*) (Sarvi et al. 2024). In contrast, HSAs have not yet been reported in Neotropical wild canids to the authors' knowledge.

The lameness observed in this case is consistent with the clinical presentation of musculoskeletal HSA in domestic dogs. In a previous study, nine of 15 (60%) dogs with muscular HSA metastases exhibited lameness or reluctance to move, often without other systemic clinical signs, leading to initial presumptive diagnoses of primary orthopedic or neurological disorders (Carloni et al. 2019). Such presentations may contribute to delayed diagnosis, particularly because deep intramuscular masses can clinically resemble inflammatory conditions and other non-neoplastic lesions, such as abscesses, hematomas, and granulomatous inflammations (Gasparini et al. 2020).

In the present case, the infiltrative, poorly demarcated appearance of the intramuscular neoplasm hindered initial suspicion of a neoplastic process, as no externally visible nodular masses were observed, unlike the exophytic lesions typically associated with cutaneous HSAs (Carloni et al. 2019). On cut section, the lesion in the hoary fox exhibited a heterogeneous appearance with extensive hemorrhagic, white, and black areas, suggesting necrosis, consistent with descriptions of HSAs in both domestic (De Nardi et al. 2023) and wild canids (Kim et al. 2015, Sarvi et al. 2024). These features are likely related to tortuous, irregular vascular channels that are frequently obstructed by thrombi, leading to ischemia, hemorrhage, and tissue necrosis. HSAs may expand locally through tissue infiltration or metastasize to distant organs and can present as solitary, multifocal, or disseminated lesions (Suzuki et al.

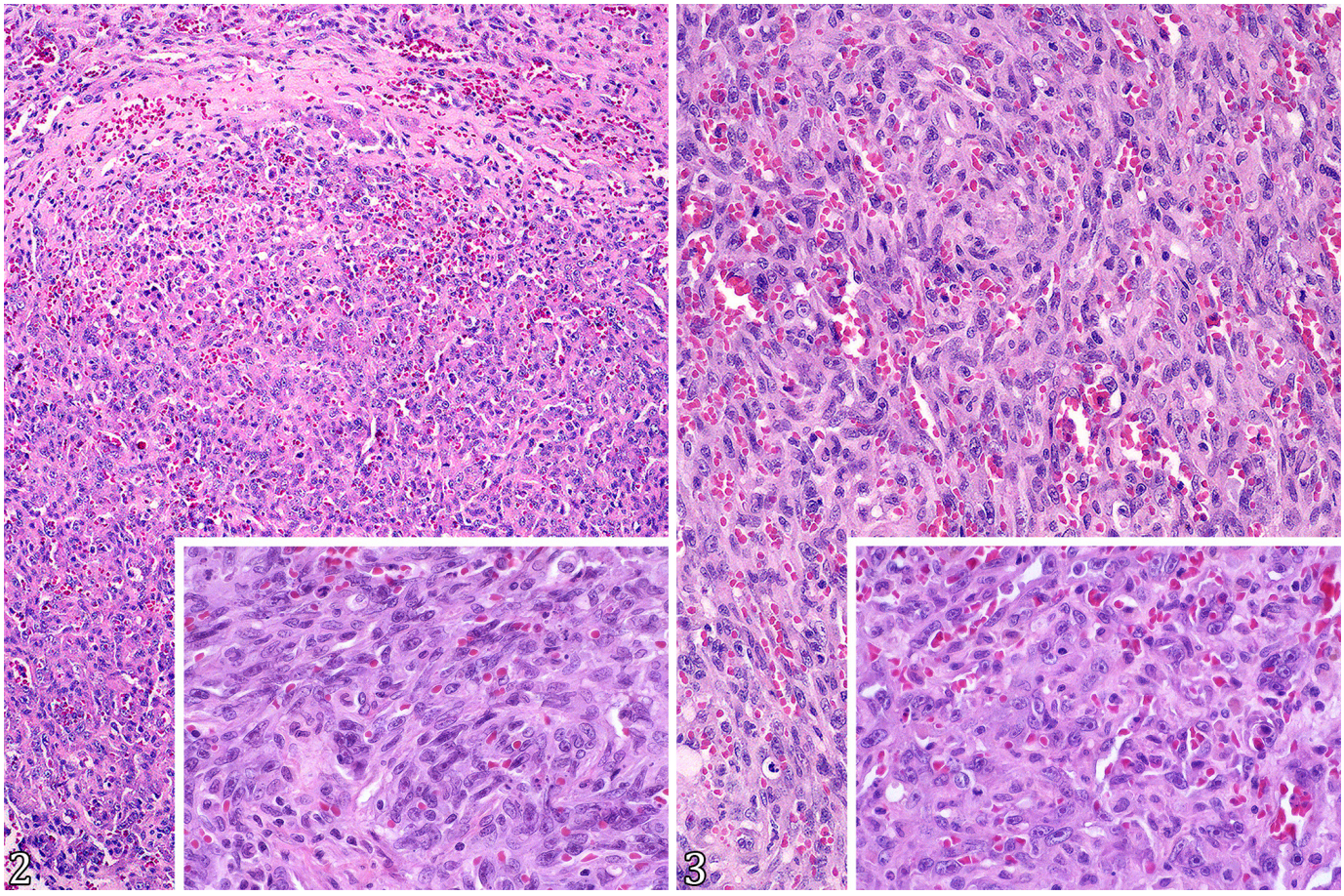


Fig. 2–3. Kaposiform intramuscular hemangiosarcoma, hory fox (*Lycalopex vetulus*). Histological findings. (**2**) Malignant solid proliferation composed of spindle cells arranged in bundles and occasionally forming vascular spaces. HE, obj. 10x. Inset: bundles of malignant spindle cells. HE, obj. 40x. (**3**) Spindle-shaped neoplastic cells, with moderate anisocytosis, anisocaryosis, and indistinct eosinophilic cytoplasm. HE, obj. 20x. Inset: pleomorphic malignant cells forming vascular spaces. HE, obj. 40x.

2024). Because intramuscular HSAs generally lack the reddish or purplish appearance characteristic of cutaneous vascular tumors, they may be easily confused with other neoplastic or non-neoplastic conditions (De Nardi et al. 2023).

The Kaposiform intramuscular HSA in the hoary fox showed a predominantly microscopic solid growth pattern, with sparse irregular vascular channels and numerous mitotic figures, findings consistent with poorly differentiated forms of this neoplasm (Roccabianca et al. 2020, Suzuki et al. 2024). In domestic dogs, HSA is recognized as a histologically heterogeneous tumor, ranging from well-formed anastomosing vascular channels to solid sheets of pleomorphic endothelial cells (Roccabianca et al. 2020, De Nardi et al. 2023). Unfortunately, in wild canids such as African wild dogs and red and gray wolves (Newell-Fugate & Lane 2009, Sarvi et al. 2024), histological classification of HSAs has not been performed for comparison with the neoplasm in the hoary fox.

In the present case, the absence of post-surgical follow-up limited further clinical evaluation. Although histological parameters such as differentiation, mitotic index, size, and invasiveness are prognostic indicators in canine soft tissue sarcomas (Kuntz et al. 1997), their relevance for hemangiosarcomas remains unvalidated, with no clear association with survival or clinical outcome (Schultheiss 2004, Bertazzolo et al. 2005). Furthermore, the lack of an established histological grading system for HSA (Bertazzolo et al. 2005, Shiu et al. 2011), together with the scarcity of reports in wild canids (Newell-Fugate & Lane 2009, Sarvi et al. 2024), precludes reliable prognostic assessment in this hoary fox.

To the best of our knowledge, this is the first report of a Kaposiform intramuscular HSA in a neotropical canid. However, it was not possible to determine whether the lesion was a primary intramuscular neoplasm or a metastatic focus, as only the amputated limb was available for evaluation, precluding assessment of distant metastatic sites and identification of a potential primary tumor. In dogs, muscular involvement by HSA is frequently associated with advanced disseminated disease affecting multiple organs (Carloni et al. 2019), although this could not be assessed in the hoary fox. A comparable case has been described in a male red wolf with metastatic HSA infiltrating the intercostal musculature of the right lateral thorax from the adjacent subcutaneous tissue (Sarvi et al. 2024). Nevertheless, visceral forms remain the most commonly reported presentations of HSA in wild canids, particularly involving the spleen, liver, and heart (Newell-Fugate & Lane 2009, Lamglait et al. 2015, Sarvi et al. 2024, Sato et al. 2024, Minichino et al. 2026).

Given the histopathological features of the Kaposiform intramuscular HSA observed in this study, immunohistochemistry (IHC) was essential for definitive diagnosis, with neoplastic cells showing immunolabeling for vimentin and the endothelial markers CD31 and Factor VIII-related antigen. In spindle-cell neoplasms

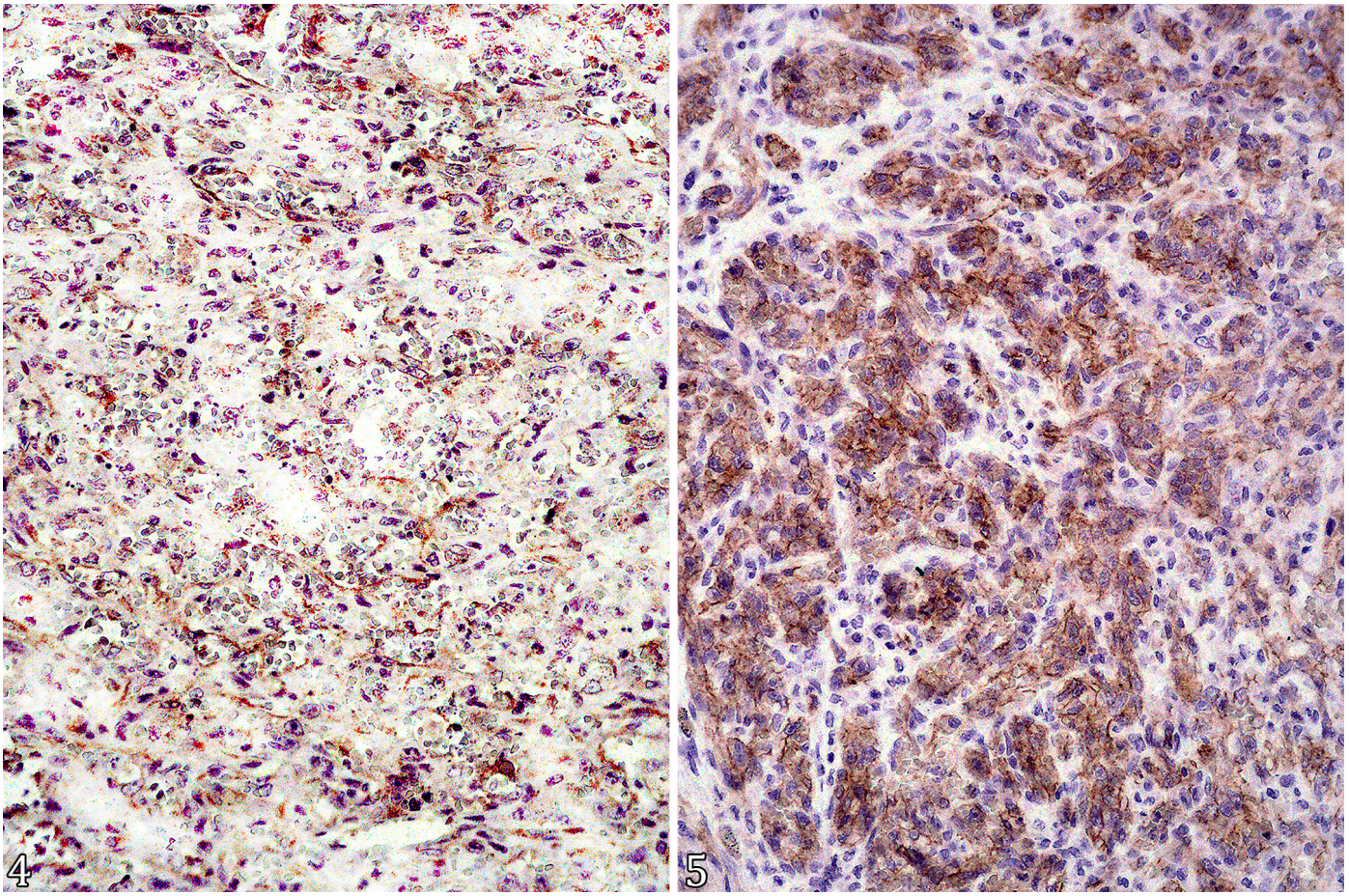


Fig. 4–5. Kaposiform intramuscular hemangiosarcoma, hory fox (*Lycalopex vetulus*). Immunohistochemical assay. (**4**) Moderate immunolabeling of malignant endothelial cells for von Willebrand factor (vWF). Immunoperoxidase, obj. 20x. (**5**) Spindle-shaped neoplastic cells with strong immunostaining for CD31. Immunoperoxidase, obj. 20x.

with predominantly solid growth patterns, specific endothelial markers are critical to confirm vascular origin (Bertazzolo et al. 2005, Chu et al. 2023) and to differentiate HSA from other primary or infiltrative intramuscular neoplasms, such as fibrosarcoma, schwannoma, and hemangiopericytoma. These neoplasms may display spindle-cell or anaplastic morphological features similar to those of solid HSAs but are typically negative for CD31 and Factor VIII immunolabeling (Ferrer et al. 1995).

The principal differential diagnoses for intramuscular hemangiosarcoma include hematomas, abscesses, hemangiomas, other spindle-cell soft-tissue sarcomas, and, in epithelioid variants, metastatic undifferentiated carcinomas (Russell et al. 1977, Sabattini & Bettini 2009). Among soft-tissue sarcomas, fibrosarcoma, leiomyosarcoma, and rhabdomyosarcoma may exhibit spindle-cell morphology and infiltrative growth within skeletal muscle; however, they differ from hemangiosarcoma by the absence of vascular channel formation and by distinct immunohistochemical profiles (Russell et al. 1977, Shi et al. 2023). In addition, hematomas and other soft-tissue neoplasms (Olimpo et al. 2023, Carafí et al. 2025), injection-site sarcomas (Jacobs et al. 2017), and foreign-body-associated sarcomas, including those related to microchips (Vascellari et al. 2006), may further complicate the definitive diagnosis of HSA. These were excluded herein based on the clinical history and pathological findings in the present case.

Positive immunolabeling for endothelial markers, together with histopathological features, was essential for confirming the vascular endothelial origin of the neoplasm and for excluding other nonvascular sarcomas in the hoary fox. Despite the study's limitations, this report contributes to current knowledge of diseases associated with lameness in Neotropical canids and expands the pathological characterization of a rare neoplasm affecting skeletal muscle.

The most relevant limitations of this study included restricted clinical information: no data on hematological or biochemical findings, therapeutic management, postoperative follow-up, or survival could be retrieved despite efforts to obtain additional information. In addition, because only the amputated limb was available for pathological evaluation, complete tumor staging and assessment of distant metastases were not possible, precluding determination of whether the lesion represented a primary intramuscular neoplasm or metastatic disease.

CONCLUSIONS

To the authors' knowledge, this report documents the first known case of Kaposiform intramuscular hemangiosarcoma (HSA) in a hoary fox, highlighting the diagnostic challenges posed by intramuscular HSAs, particularly when clinical signs are nonspecific (lameness) and external masses are absent. Histopathology combined with immunohistochemistry was essential for establishing the definitive diagnosis and differentiating the tumor from other spindle-cell neoplasms of skeletal muscle. Although the absence of complete staging and clinical follow-up limited assessment of the tumor's biological behavior and prognosis, the findings suggest an aggressive and infiltrative neoplasm.

Given the scarcity of information on neoplastic diseases in Neotropical canids, this report reinforces the importance of including HSA in the differential diagnosis of muscular lesions associated with locomotor abnormalities in captive wildlife species.

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Conflict of interest statement.- The authors declare that they have no conflicts of interest.

Credit author statement.- Davi S. Leal and Márcio B. Castro: Conceptualization, Supervision, Project administration, Resources, Writing – original draft, Writing – review & editing. Liz A. Cerqueira: Data curation, Investigation, Visualization, Writing – original draft, Writing – review & editing. Daniela O. Rocha, Gabriel A.O. Bezerra, Isabel Luana de Macêdo, Dara E. V. da Costa, and Líria Q. L. Hirano: Data curation, Formal analysis, Investigation, Methodology, Writing – review & editing. All authors approved the final version of the manuscript.

Data availability statement.- All data supporting the findings are within this study and are also available from the corresponding author upon reasonable request.

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