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Case Report

Metastatic ovarian carcinoma in white-tailed deer (Odocoileus virginianus) from a conservation center in Medellín-Colombia

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Abstract
Wildlife animals in human care can develop pathological processes that rarely occur in their natural habitats, including neoplastic disorders. This report presents the post-mortem pathological findings of a white-tailed deer (*Odocoileus virginianus*) from a conservation center in Medellín, Colombia. *O. virginianus* had lung metastases originating from a primary papillary ovarian carcinoma. The post-mortem examination revealed macroscopic and microscopic involvement of multiple organs, including the ovaries, uterus, lungs, kidneys, liver, and spleen. Immunohistochemical analysis showed positive staining for pancytokeratin in neoplastic epithelial cells. This case underscores the importance of recognizing and understanding the multi-causal pathological processes contributing to the death of a wild animal in captivity.

Keywords: cancer, cervid, ovarian diseases, wildlife, neoplasia.

Introduction

The white-tailed deer (*Odocoileus virginianus*) is an ungulate mammal of the family Cervidae widely distributed across the Americas (5). As a flagship species, it maintains ecosystem balance and holds significant game value (6). In human-managed wildlife populations, disease incidence varies due to continuous and highly specialized veterinary care, as well as the ability to perform paraclinical tests that allow for a definitive diagnosis (15).

Notably, neoplasm diagnosis is more frequent in conservation settings due to increased longevity (13). Neoplasms are multifactorial pathological processes involving environmental, genetic, infectious, and other factors (7). This report presents the case of an *O. virginianus* with a papillary ovarian carcinoma with lung metastases and multiple multisystemic pathological processes that led to the specimen's death. Epithelial ovarian tumors originate from the surface epithelium and are characterized by a multinodular, cystic, cauliflower-like appearance (1, 12). They tend to disseminate within the peritoneal cavity. Metastasis frequently occurs following the rupture of one of the cysts, with tumor cells spreading via lymphatic or venous invasion to organs such as the lungs, lymph nodes, among others (10).

Case description

Origin, history, and clinical findings

The white-tailed deer (*O. virginianus*) specimen was in captivity at the Parque de la Conservación in Medellín,

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Antioquia, Colombia. The six-year-old female, born in captivity, shared its enclosure with ten castrated conspecifics. No breeding activities, pregnancies, or births were recorded. When the deer exhibited lethargy, weakness, and anorexia, its diet was supplemented with omeprazole (0.7 mg/kg) and vitamin E with selenium (1000 IU). As the condition did not improve, the animal was captured using ketamine (7.5 mg/Kg), midazolam (0.225 mg/Kg), and butorphanol (0.2 mg/Kg).

Clinical examination revealed a body condition score of 4/9, weighing 28 kg, pale mucous membranes, and bloody diarrhea in the perianal region. The animal underwent oxygenation for 15 minutes and was maintained under inhalation anesthesia with 1-2% isoflurane. Fluid therapy was initiated with a multielectrolyte solution (60 mL/kg/day), accompanied by: Metronidazole (20 mg/kg IV), Dipyrone (28 mg/kg IV), Ivermectin (0.2 mg/kg SC), N-acetylcysteine (30 mg/kg), Maropitant (1 mg/kg SC), Iron (5 mg/kg IM), ATP (0.1 mL/kg), Etamsylate (7.5 mg/kg). However, profuse anal bleeding was observed approximately 40 minutes later, prompting administration of tranexamic acid (10 mg/kg IV).

Cardiorespiratory arrest occurred at the procedure's end. Resuscitative efforts included: Doxapram (5 mg/kg), Endotracheal intubation, Cardiopulmonary resuscitation maneuvers, Epinephrine (0.05 mg/kg IV, two doses at 5-minute intervals, followed by a third dose of 0.1 mg/kg IV). Despite these efforts, death was declared after 15 minutes.

Diagnostic Plan

Hematological analysis revealed normocytic normochromic anemia, polychromasia with moderate hypochromia, circulating metarubricytes, target cells, anisocytosis, echinocytes, acanthocytes, microcytosis, and leukocytosis due to neutrophilia (Table 1). Additionally, elevated serum creatinine, blood urea nitrogen, and aspartate aminotransferase activity were observed (Table 1). A coprological examination showed erythrocytes and dysbiosis. Gram staining revealed a diverse microbiota comprising cocci, coccobacilli, and bacilli. Parasitological analysis using the McMaster technique identified nematode infection (Strongylodidae family) with a fecal egg burden of 256 eggs per gram. Molecular testing by RT-PCR was positive for *Dirofilaria* spp. (6500 copies/µL), Microagglutination test was negative for *Leptospira* spp., and Rose Bengal test: was negative for *Brucella abortus.*

Pathological evaluation

An external examination, a thorough external inspection from head to tail was performed, revealing a total body length of approximately 105 cm (Fig. 1A). Key observations included erosion on the left haunch, hematochezia, improper development of two incisors, and absence of two premolars on the left maxilla.

In the reproductive system, the left ovary presented a 2 cm diameter, dark-red, round structure with multiple black and whitish nodules. The right ovary measured 2 x 1.5 cm, featuring a red nodule and a cyst associated with periovarian tissue. Notably, the right uterine horn was disproportionately larger (4:1 ratio) than the left. Cross-sectional analysis revealed a thickened endometrium with abundant opaque, dense, white-yellowish content (Fig. 1B). The liver exhibited a brownish-icteric discoloration with multiple small whitish foci and a mottled "nutmeg" pattern (Fig. 1C). Numerous nodules approximately 0.1 cm in diameter and a subcapsular cyst were identified upon sectioning.

In the respiratory system, petechiae, hyperemia, and venous congestion in paranasal sinuses were identified. The thoracic cavity contained a moderate amount of yellowish, serous, opaque transudate with few adhesions involving the pericardium and pleura. The lungs, particularly in the cranial lobes, showed multiple whitish foci of moderate firmness, emphysematous areas in the caudal borders, and a whitish nodule in the cranial region (Fig. 1D).

Histopathological analysis was performed from the ovaries, uterus, lungs, kidneys, liver, and spleen using hematoxylin-eosin (HE) staining. Additionally, immunohistochemistry was conducted on the ovarian neoplasm using

Table 1. Hematological and serum biochemical findings in an *Odocoileus virginianus*.

Parameter	Absolute value	Relative value (%)	Unit
Erythrocytes	3000000		Eri/µL
Hemoglobin	5.0		g/dL
Hematocrit	15		%
MCV	50		fL
MCH	16.33		pg
MCHC	33.33		g/dL
Platelets	127000		Plt/ µL
MPV	6.4		fL
Total protein	34		
Leukocytes	15300		Leu/µL
Netrophils	13617	89	Neu/µL
Band neutrophils	0	0	Band/µL
Lymphocytes	1683	11	Lym/µL
Monocytes	0	0	Mon/µL
Eosinophils	0	0	Eos/µL
Basophils	0	0	Baso/µL
Blood urea nitrogen	56.51		mg/dl
Creatinine	3.25		mg/dl
Aspartate aminotransferase	476.19		U/L

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anti-Cytokeratin 19 (BA17) antibodies (Vitro, Master Diagnóstica, Spain®) to further characterize the tumor.

The ovarian analysis revealed a multilobular epithelial neoplasm (Fig. 2A), infiltrating stromal tissue (Fig. 2B). The neoplasm formed tubules or papillae lined by simple to stratified cuboidal to columnar ciliated epithelium. The neoplastic cells displayed round to elongated nuclei with vesicular chromatin and prominent, multiple nucleoli. Moderate poikiloanisokaryosis and numerous tumor emboli were observed (Fig. 2C). Additionally, vascular, necrotic, and inflammatory changes were present, alongside severe interstitial fibrosis (Fig. 2B) and pronounced atrophy of ovarian follicles. Moderate atrophy of the endometrial lining and glandular epithelium was also noted, with cystic glands and moderate to severe fibrosis in the submucosal lamina propria.

In the lungs, interstitial thickening of alveolar septa was observed, caused by circulatory disorders and leukocytic infiltration, extending to alveolar lumens. Multiple blood vessels contained tumor emboli of epithelial neoplasms (Fig. 2D). Marked proliferation of alveolar macrophages with anthracosis deposits was present in the alveoli.

Renal interstitial examination revealed multiple circulatory disturbances, including a large thrombus with degenerated neutrophils, fibrin, erythrocytes, and canalization processes. Tubular degeneration and moderate necrosis with eosinophilic granular material in the tubular lumens were evident (Fig. 2E). In the liver, centrilobular necrosis and bile duct hyperplasia were identified. The spleen exhibited severe hemorrhage and vascular congestion in the red pulp, with abundant hemosiderin deposits. Severe lymphoid depletion. Figure 2F highlights strong, predominantly perimembranous immunostaining of neoplastic epithelial cells for pancytokeratin antibodies.

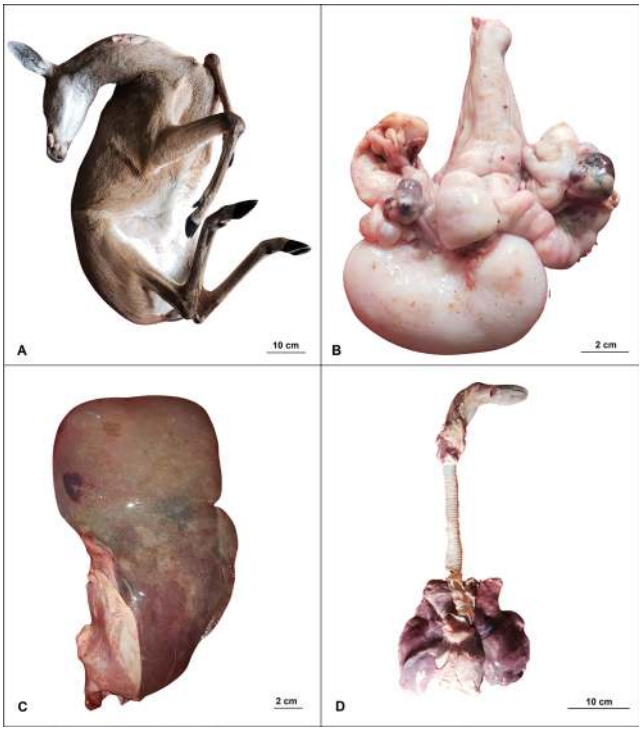

Figure 1. Photographs taken at the necropsy of *O. virginianus*. A. Dorsoventral view of a white-tailed deer, showing an alopecic area, likely corresponding to venous access at the jugular level. B. Photograph of the reproductive tract, displaying a 4:1 ratio between the uterine horns, with the presence of cysts and ovarian masses. C. Brownish-icteric liver with whitish foci. D. Cardiorespiratory organ package.

Discussion

This report presents the first case of ovarian neoplasia in *O. virginianus*. To date, scientific literature on benign or malignant neoplasms in white-tailed deer remains limited and outdated. However, cases of squamous cell carcinoma, osteochondroma, urothelial carcinoma, lymphosarcoma, and hepatocellular adenocarcinoma have been reported (3, 16, 17, 18, 19, 20). This case contributes to the limited knowledge on neoplasms in white-tailed deer and highlights the importance of continued research in this area.

This case highlights the presence of renal injury, dirofilariasis, and strongyloidiasis, with hemodynamic results supporting the pathophysiological processes that led to the individual's death (Figure 3). Reproductive neoplasms in wildlife pose a significant concern for conservation efforts, as they can impact population dynamics (15). Notably, such conditions are thought to occur more frequently in captive wildlife due to human-induced factors, including altered sex ratios, contraceptive treatments, and environmental changes (15).

Although papillary ovarian carcinoma has not been reported in *O. virginianus*, similar ovarian lesions, such as luteomas and papillary cystadenomas, have been documented in cattle (12, 21). Notably, this study employed pancytokeratin as a diagnostic tool, differing from Kita et al. (10), who used cytokeratin 7 for immunohistochemistry. This application of pancytokeratin in deer expands the diagnostic repertoire in wildlife medicine.

Systemic processes associated with ovarian carcinomas are not well understood in animals due to the limited number of reported cases. In this case, uterine changes were linked to endometrial atrophy caused by a hydrometra, characterized by proteinaceous, low-cellularity content. Comparative studies in dogs have reported transcelomic metastasis from the ovary to the uterus (2) and associations between ovarian papillary carcinoma and pyometra, adenomyosis, and endometrial hyperplasia (10). However, these features were absent in the deer. The uterine findings in this deer may be due to ovarian tissue replacement by epithelial neoplasia, leading to reduced hormone production, mimicking a menopausal state with decreased uterine stimulation and, in some cases, hydrometra formation (11).

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Figure 3 illustrates the proposed pathophysiological process in this case. Several mechanisms have been implicated in cancer development, including (I) Immunosuppression: Impaired immune function fails to eliminate cells with phenotypic and genotypic alterations, facilitating tumor growth (4). (II) Genetic factors: Failures in genes regulating cell proliferation, differentiation, and tumor suppression, as well as repair defects and apoptosis dysregulation, contribute to cancer development (9). (III) Chronic inflammation: Persistent inflammatory processes induce DNA damage, alter the microenvironment, and suppress immune responses, promoting tumorigenesis (22). (IV) Endocrine stimuli: Both endogenous and exogenous hormonal stimuli can promote cell proliferation and increase opportunities for genetic errors, contributing to cancer development (8).

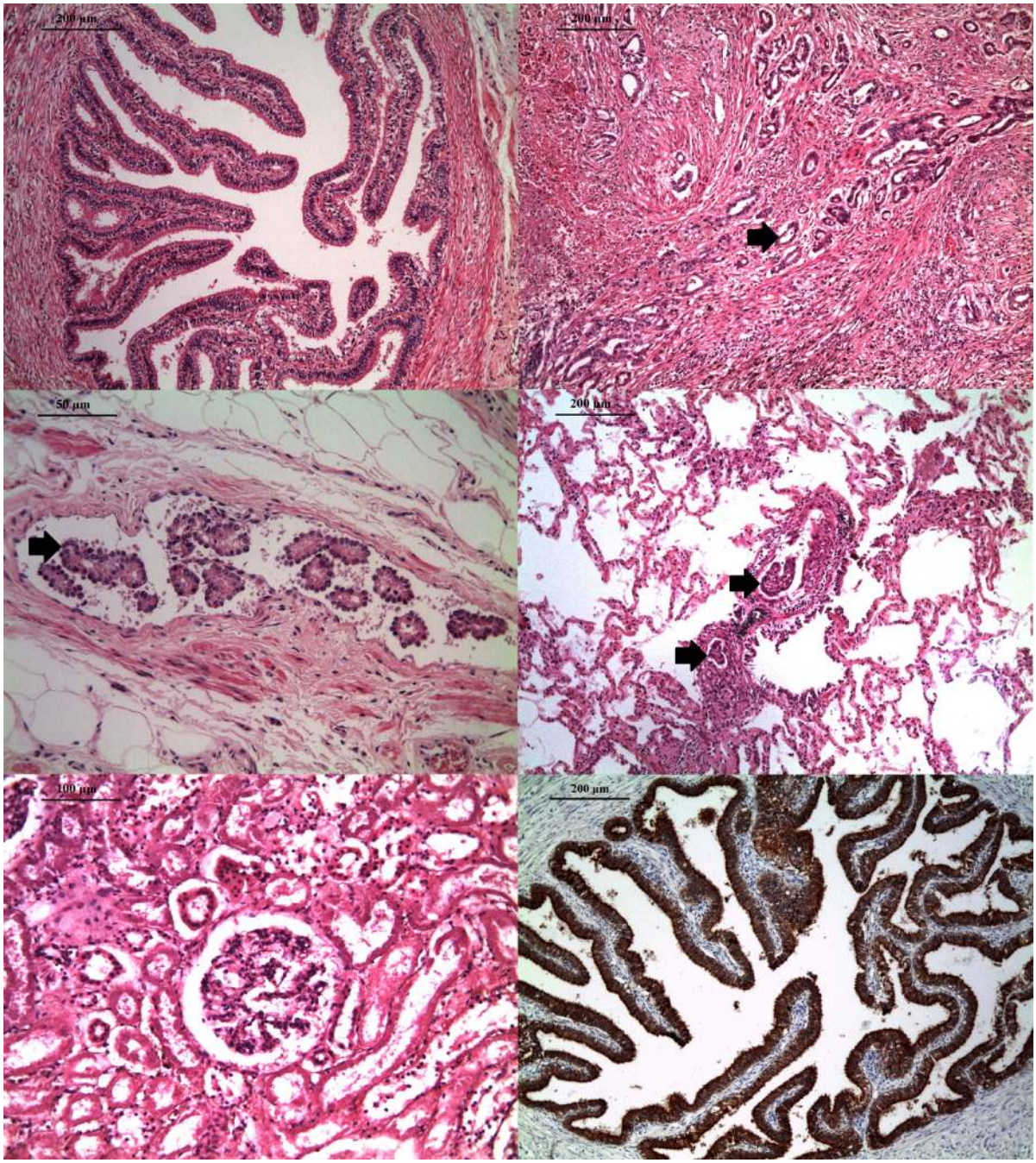

Figure 2. Microphotographs of histopathological lesions in *O. virginianus* .A. Ovary. H-E, 10x: Papillary epithelial neoplasm observed. B. Ovary. H-E, 10x: Neoplastic structures infiltrating the organ's stroma are visible. C. Ovary. H-E, 40x: Tumor emboli in the lumen of a vein near the tunica albuginea (black arrow). D. Lung. H-E, 10x: Tumor emboli (arrows) evident in the pulmonary interstitium. E. Kidney. H-E, 20x: Tubular epithelial necrosis identified. F. Ovary. IHC, 10x: Marked immunostaining in neoplastic epithelial cells visible.

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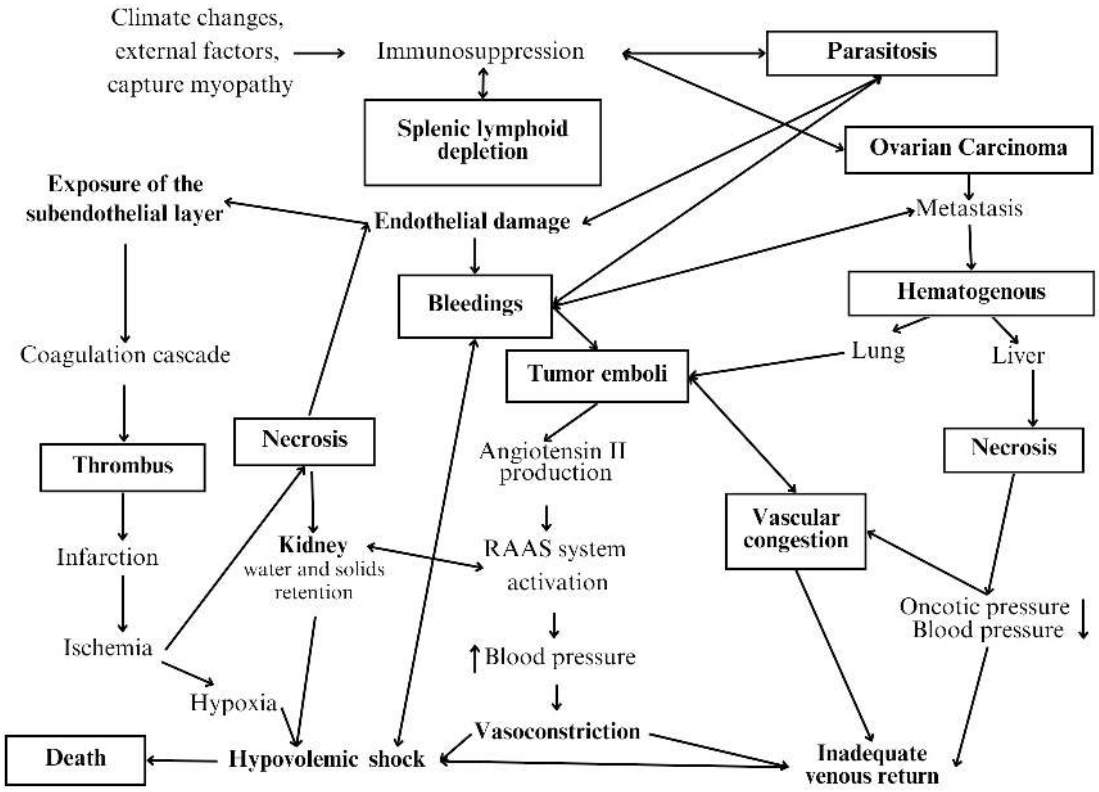

Figure 3. Suggested Pathophysiology in the white-tailed deer (*Odocoileus virginianus*). The pathological processes within boxes represent the macroscopic or microscopic alterations observed in the patient. Unboxed elements depict the suggested pathophysiological processes.

Stress, potentially triggered by climatic changes, parasitic gastroenteritis, or unidentified factors, may have further contributed to immunosuppression, as evidenced by splenic lymphoid depletion. The interplay of these factors culminated in the ovarian carcinoma's presentation and subsequent metastasis, causing significant endothelial damage. This damage led to hemorrhages and thrombi in multiple organs, such as the kidneys and lungs. The renin-angiotensin-aldosterone system was likely activated to regulate blood pressure and compensate for hypotension (14). Additionally, baroreceptor-mediated catecholamine release, vasoconstriction, and antidiuretic hormone activity may have exacerbated blood volume retention in the kidneys (14). Hepatic metastasis, combined with observed hepatic necrosis (potentially due to systemic hypoxia), may have led to liver failure, reducing oncotic pressure and promoting interstitial fluid extravasation, thereby worsening hypotension. The observed hematochezia and hematological abnormalities further suggest the development of shock, which was likely a critical factor contributing to the patient's death.

It is recommended to promote the publication of case reports like this one, given their invaluable contribution as fundamental pillars for more applied research in the field. It is crucial to highlight that there is a notable scarcity of studies delving into *post-mortem* analysis of neoplasms in wildlife animals. Moreover, this case underscores the importance of incorporating paraclinical diagnostic tools such as histopathology and exploring the applicability of immunohistochemical markers commonly used in domestic animals. Future research should also emphasize the need for more comprehensive clinical evaluations, particularly those focused on oncology, in geriatric captive wildlife. These efforts can enhance early detection and improve management strategies, ultimately contributing to better health and welfare outcomes for aging wild animals under human care.

Conflict of Interest

The authors declare no competing interests.

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