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Original Article
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Feline multicentric sarcomas in 12 cats: pathological features[1]

Rafael B. Rosa[2]*, Paula R. Ribeiro[2], Vanessa C. Pereira[2], Paula R. Pereira[2], Saulo P. Pavarini[2], Luciana Sonne[2]

ABSTRACT.- Rosa RB, Ribeiro PR, Pereira VC, Pereira PR, Pavarini SP, Sonne L. **Feline metastatic or multicentric sarcomas in 12 cats: pathological features**. *Pesquisa Veterinária Brasileira 46:e07840, 2026.* Setor de Patologia Veterinária, Universidade Federal do Rio Grande do Sul, Porto Alegre, RS 91540-000, Brazil. E-mail: rafael.biondo94@gmail.com

Metastatic or multicentric sarcomas are rare in domestic cats. Necropsy reports from the "Setor de Patologia Veterinária" of the "Universidade Federal do Rio Grande do Sul" (2012–2022), identified 12 cases, including feline injection site sarcomas (FISS; 4/12, 33.3%), histiocytic sarcomas (3/12, 25%), visceral spindle cell sarcomas without skin involvement (3/12, 25%), and hemangiosarcomas (2/12, 16.7%). Most FISS (3/4, 75%) were fibrosarcomas, and one was osteosarcoma. Primary sites of visceral spindle cell sarcomas included the esophagus, with one case each of myxosarcoma and undifferentiated sarcoma, and the urinary bladder, with one case of undifferentiated sarcoma. Grossly, 10/12 cases (83%) showed white-to-tan masses, except for hemangiosarcomas, which had multifocal dark red-purple masses. Lungs were affected in 11/12 cases (91.7%), followed by kidneys (6/12, 50%), skin (6/12, 50%), and liver (4/12, 33.3%). Metastatic/multicentric sarcomas are heterogeneous, with varied clinical manifestations, except metastatic FISS, which presented as large masses at injection sites. Metastasis or multicentric involvement led to poor survival, with a median survival time (MST; n = 10) of 40 days (range, 2–240 days).

INDEX TERMS: Metastasis, sarcomas, feline.

RESUMO.- [**Sarcomas multicêntricos ou metastáticos em 12 gatos: aspectos patológicos.**] Sarcomas metastáticos ou multicêntricos são raramente relatados em gatos domésticos. A partir da base de dados do Setor de Patologia Veterinária da Universidade Federal do Rio Grande do Sul (2012–2022), foram identificados 12 casos: sarcomas em locais de aplicação (FISS; 4/12, 33,3%), sarcomas histiocíticos (3/12, 25%), sarcomas viscerais de células fusiformes sem envolvimento cutâneo (3/12, 25%) e hemangiossarcomas (2/12, 16,6%). A maioria dos FISS (3/4, 75%) foram classificados como fibrossarcomas e apenas um como osteossarcoma. Sítios primários dos sarcomas viscerais de células fusiformes foram o esôfago (dois casos: mixosarcoma e sarcoma indiferenciado) e a bexiga urinária (um caso: sarcoma indiferenciado). Macroscopicamente, 10 casos (83%) apresentaram massas brancas a castanho-claras, exceto os hemangiossarcomas, que formaram múltiplas massas vermelho-escuras. Pulmões foram afetados em 11/12 casos (91,7%), seguidos por rins e pele (6/12, 50% cada) e fígado (4/12, 33,3%). Sarcomas metastáticos/multicêntricos são heterogêneos, com manifestações clínicas variadas, exceto FISS metastáticos, que surgem como grandes massas nos locais de aplicação. Metástases ou envolvimento multicêntrico resultou em baixa sobrevida, com tempo de sobrevida mediano (MST; n = 10) de 40 dias (2–240).

TERMOS DE INDEXAÇÃO: Metástase, sarcomas, gatos.

INTRODUCTION

Feline sarcomas include soft tissue sarcomas (STS), injection-site sarcomas (FISS), histiocytic sarcomas (HS), and hemangiosarcomas. STS arise from mesenchymal cells, with cutaneous and subcutaneous forms being the most common. In contrast, FISS develop at inflammatory sites and may resemble fibrosarcoma, osteosarcoma, or pleomorphic sarcoma, with local recurrence as the main prognostic factor (Roccobianca et al. 2020, Dobromylskyj et al. 2021). HS, as well as disseminated histiocytic sarcomas (DHS), arise from interstitial dendritic cells and may present as multifocal internal organ masses with poor prognosis (Affolter & Moore

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[2] Setor de Patologia Veterinária, Universidade Federal do Rio Grande do Sul (UFRGS), Porto Alegre, RS 91540-000, Brazil. *Corresponding author: rafael.biondo94@gmail.com

2002, Moore 2017). Reports on multicentric or metastatic sarcomas in cats are limited; thus, this study aimed to describe the pathological features of these tumors, including DHS, FISS, visceral spindle cell sarcomas, and hemangiosarcomas.

MATERIALS AND METHODS

Ethical approval. Samples were submitted as part of routine diagnostic testing in accordance with institutional and national guidelines and did not require ethical approval.

Cases of metastatic or multicentric sarcomas in cats were retrospectively retrieved from the pathology database of the "Setor de Patologia Veterinária" (SPV) of the "Universidade Federal do Rio Grande do Sul" (UFRGS). Necropsy records were searched using the keywords "cat", "sarcoma", "metastatic", and "multicentric". Only necropsy cases were included in this study, except for Case 7 (injection-site sarcoma), in which the primary tumor had been previously diagnosed after right hindlimb amputation. The hematoxylin and eosin (HE)-stained histological slides were reviewed. "Multicentric" was defined as simultaneous involvement of multiple organs/tissues without identification of a clear primary site. Only cases with microscopic evidence of metastasis/multicentric involvement were included. Clinical data were obtained from medical records and included signalment, *feline leukemia virus and feline immunodeficiency virus* (FeLV/FIV) status, and survival time (from diagnosis to death). The FISS diagnosis was based on tumor location at typical injection sites and histologic features such as necrosis, peripheral inflammation, and subcutaneous origin (Aberdein et al. 2007, De Cecco et al. 2019).

The differentiation between feline injection-site sarcomas (FISS) and visceral spindle cell sarcomas was performed based on previously established clinicopathological criteria. Tumors were classified as FISS when they were located at anatomical sites consistent with injection administration. In contrast, visceral spindle cell sarcomas not associated with injection sites were defined by the absence of topographical association with vaccination areas and by a multicentric/metastatic distribution involving organs within the abdominal and thoracic cavities. Histiocytic sarcoma was diagnosed based on histological criteria, including a predominance of round-to-polygonal cells, frequent multinucleation, and marked nuclear and cytoplasmic pleomorphism. Hemangiosarcoma was discriminated by histological evaluation, characterized by the proliferation of neoplastic endothelial cells forming irregular vascular spaces.

Formalin-fixed paraffin-embedded tissues were submitted to immunohistochemistry (IHC) using antibodies against CD3, CD20, IBA-1, anti-human macrophage (MAC 387), E-cadherin, and vimentin for histiocytic sarcomas, and vimentin, desmin, smooth muscle actin (α-SMA), and S100 for FISS and visceral spindle cell sarcomas. An amplification signal was obtained (Novolink-Max polymer Detection System – LEICA) and revealed with 3-amino-9-ethylcarbazole (AEC) (Table 1). Appropriate external and internal positive controls were used, and negative controls were processed with PBS instead of primary antibodies. Descriptive statistics were performed; normally distributed variables (e.g., age) were expressed as mean ± SD, and non-normal variables (e.g., survival time) as median and range.

RESULTS

Of the 2,112 feline cases entered into SPV-UFRGS from 2010 to 2022, neoplasms represented 24.28%. Among 513 cases of feline neoplasms, metastatic or multicentric sarcomas comprised 2.33%. The average age of affected cats was 11 ± 3.3 years. Most cats (11/12, 91.6%) were euthanized because of a poor prognosis after the diagnosis, except for one cat (Cat 9) that died of natural causes. Relevant information (diagnosis, age, breed, clinical presentation, survival outcome) for each case and the affected organs are summarized in Table 2 and 3. Retrovirus status was reported in only six cases, of which only one case (Case 3) was positive for FeLV.

Histiocytic sarcomas

Histiocytic sarcomas were diagnosed in three cats, comprising 25% of all cases included in this study and 0.6% of all feline neoplasms diagnosed in the evaluated period. In Cases 1 and 3, a locally invasive subcutaneous mass-growing was observed in the inguinal and perianal regions, respectively. In Case 1, the lesions consisted of multiple, tan-white, flat nodules with invasion of adjacent parenchyma and affected kidneys, liver, pancreas, heart, adrenals, and lungs (Fig. 1). The spleen had 0.4–1.0 cm, multifocal, elevated, tan-white growths (Fig. 2) on the capsular surface. On the cut surface, these were well

Table 1. Antibodies, clones, and immunohistochemical protocols applied to the cases

Antibody/code	Positive control tissue	Clone	Antigenic recovery	Dilution
CD3/A0452[a]	Lymph node	Polyclonal	15 min protease XIV, at room temperature	1:250
CD20/PA516701[b]	Lymph node	Polyclonal	Heat (microwave), 10 min in pH 9.0 Tris EDTA	1:400
IBA-1/A1527[c]	Lymph node	Polyclonal	Heat (pressure cooker), 40 min in pH 6.0 citrate buffer at 96 °C	1:2000
Anti-human-macrophage/M0747[a]	Reactive histiocytosis	Monoclonal (mac387)	Heat (pressure cooker), 40 min in pH 6.0 citrate buffer at 96 °C	1:20
E-Cadherin/M3612[a]	Internal positive control and haired skin	Monoclonal (nhc-38)	Heat (microwave), 15 min in pH 6.0 citrate buffer	1:100
Vimentin/18-0052	Small intestine	Monoclonal (v9)	Heat (pressure cooker), 40 min in pH 6.0 citrate buffer at 96 °C	1:200
Desmin/M0760[a]	Small intestine	Monoclonal (d33)	Heat (microwave),10 min in pH 9.0 Tris EDTA	1:300
α-SMA/M0851[a]	Small intestine	Monoclonal (1a4)	Heat (pressure cooker), 20 min in pH 9.0 Tris EDTA at 120 °C	1:50
S100/IR504[a]	Canine melanoma	Polyclonal	Heat (pressure cooker), 20 min in pH 6.0 citrate buffer at 96 °C	Ready-to-use

[a] Dako, Carpinteria, California, USA; [b] Invitrogen, Carlsbad, California, USA; [c] ABClonal Technology, Massachusetts, USA; AEC = 3-amino-9-ethylcarbazole (Biocare®), IBA-1 = ionized calcium binding adapter molecule 1, α-SMA = alpha smooth muscle actin.

demarcated and bulged from the capsular surface. The inguinal, tracheobronchial and iliac lymph nodes were enlarged, firm and had loss of corticomedullary distinction.

Gross changes in Case 2 consisted of a white solid mass (6.0 x 4.0 x 1.0 cm) located in the caudal portion of the esophagus with invasion of the mediastinum, and affecting mostly the caudal lung lobes (Fig. 3). The adjacent tracheobronchial lymph nodes were enlarged and firm, as well as the iliac lymph nodes. Multiple white nodules measuring 2–3 cm in the cortex of both kidneys were observed (Fig. 4). Case 3 had involvement of both kidneys, heart, ureter, eyes, thyroid, and lungs. Both the right and left kidneys were enlarged with irregular capsular surfaces, and on the cut surface, multiple white masses coalesced and extended from the cortex to the medulla. Unilateral hydronephrosis developed secondary to a nodule of 2.5 cm in diameter in the proximal left ureter, which protruded into the lumen and obstructed the urinary flow. On vertical sections of the eyes, a white to red solid mass effaced the uvea and extended into the anterior chamber. Moreover, the lungs and epicardium had multiple well-demarcated white nodules of up to 0.5 cm. Similar lesions were found in the parietal pleura, mostly in the intercostal muscles.

Histologically, all lesions observed at necropsy corresponded to a proliferation of neoplastic histiocytic cells. Bone marrow infiltration by neoplastic histiocytes was observed only in Case 3. In all cases, the neoplastic cells were round and markedly anaplastic (Fig. 5), with abundant eosinophilic cytoplasm and indented hyperchromatic nuclei. Multinucleate neoplastic cells and karyomegaly were observed in all three cases. Numerous mitoses were observed, including bizarre mitotic figures, and the mitotic count ranged from 11 to 15 in 2.37 mm^2. The neoplastic cells exhibited marked, multifocal membranous-to-cytoplasmic immunolabeling for IBA-1 (Fig. 6) and vimentin. The other immunomarkers (MAC 387, CD3, CD20 and E-cadherin) were negative.

Feline injection site sarcomas

The most common histologic diagnosis was fibrosarcoma (Cases 4, 5 and 7; 3/4, 75%), and a single case of osteosarcoma was diagnosed (Case 6; 1/4, 25%). White firm masses in the subcutis were observed in all cases, including an 18 x 13 x 7 cm invasive subcutaneous mass in the cervical and interscapular region in Cat 4 (Fig. 7). Pulmonary metastasis involved multiple lung lobes, characterized by pinpoint,

Table 2. Diagnosis, first clinical presentation and overall survival of cases of feline metastatic or multicentric sarcomas

Case	Diagnosis	Age (years)	Sex	Breed	Clinical course (days)	First clinical presentation
1	HS	15	Male	DSH	17	Anorexia and dyspnea
2	HS	8	Female	DSH	22	Anorexia and perianal subcutaneous growth
3	HS	4	Male	DSH	-	Anorexia and bilateral renomegaly
4	FISS	10	Male	DSH	35	Invasive local growth in SC
5	FISS	6	Female	DSH	114	Invasive local growth in SC
6	FISS	10	Female	DSH	93	Invasive local growth in SC
7	FISS	9	Female	DSH	-	Invasive local growth in SC
8	VSCS	11	Female	DSH	240	Dysuria and weight loss
9	VSCS	16	Male	DSH	13	Regurgitation
10	VSCS	10	Male	DSH	120	Regurgitation
11	HSA	12	Female	DSH	45	Subcutaneous mass at abdominal wall
12	HSA	13	Male	DSH	2	Anorexia

HS = histiocytic sarcoma, DSH = domestic shorthair, FISS = feline injection site sarcoma, SC = subcutaneous, VSCS = visceral spindle cell sarcoma, HSA = hemangiosarcoma; (-) Missing information.

Table 3. Affected sites in feline metastatic or multicentric sarcomas

Case	Diagnosis	Affected organs
1	HS	Lungs, kidneys, skin, heart, liver, pancreas, adrenal, spleen, lymph node
2	HS	Lungs, kidneys, skin, esophagus, lymph node
3	HS	Lungs, kidneys, heart, ureter, bone marrow, thyroid, ocular globe, intercostal musculature, lymph node
4	FISS	Lungs, skin
5	FISS	Lungs, skin
6	FISS	Lungs, skin
7	FISS	Lungs, kidneys, skin, central nervous system, intercostal musculature
8	VSCS	Lungs, kidneys, skin, bladder, liver, adrenal, lymph node
9	VSCS	Lungs, esophagus
10	VSCS	Lungs, esophagus
11	HSA	Lungs, kidneys, skin, liver, heart, pancreas, heart, central nervous system, lymph node
12	HSA	Colon, liver, lymph node

HS = histiocytic sarcoma, FISS = feline injection site sarcoma, VSCS = visceral spindle cell sarcoma, HSA = hemangiosarcoma.

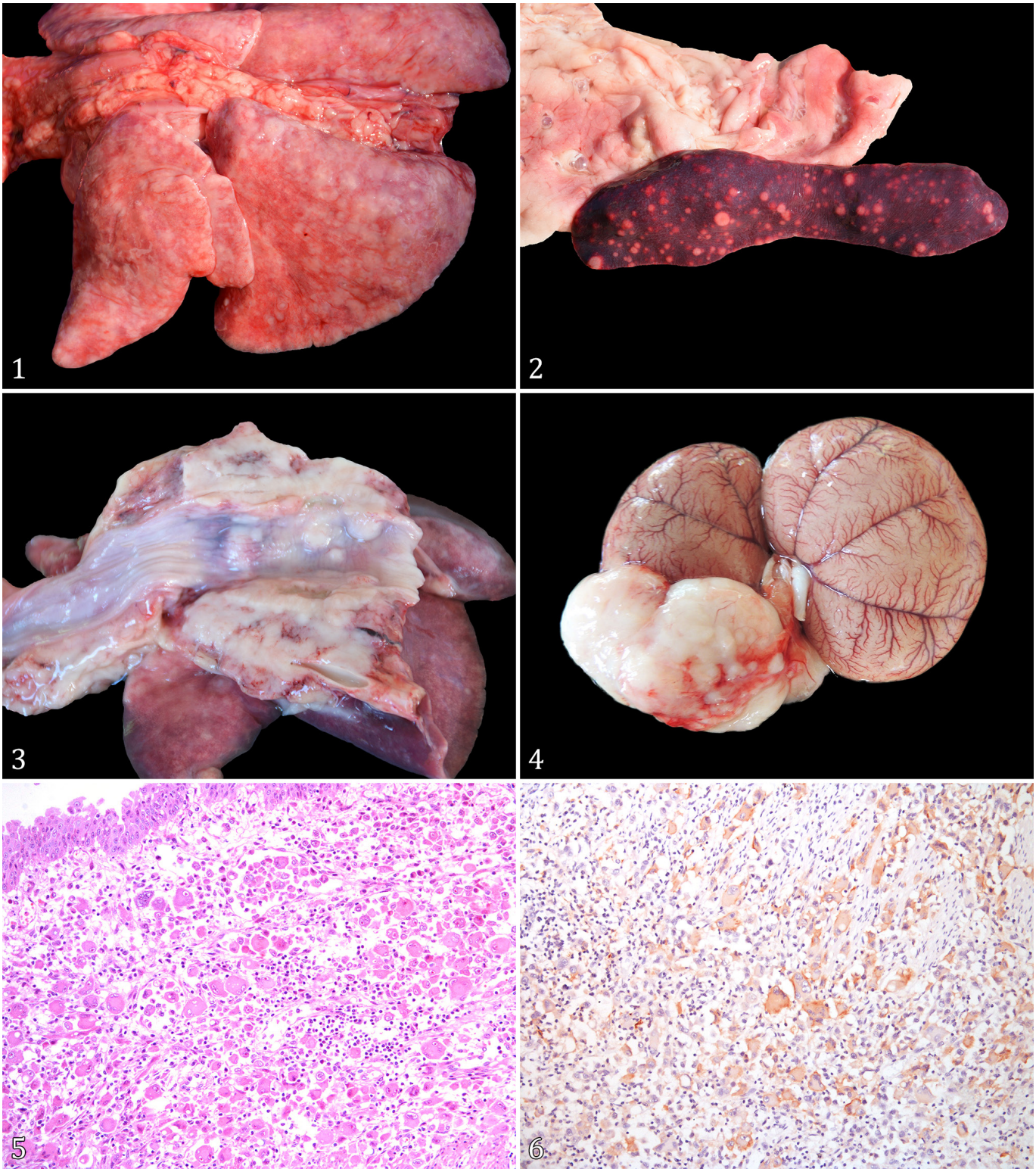

Fig. 1-6. Gross and histological features of histiocytic sarcomas in cats. (**1**) Case 1, lungs: multiple multifocal to coalescent flattened white nodules in multiple lung lobes. (**2**) Case 1, spleen: metastases appear as small white nodules on the capsular surface. (**3**) Case 2, mediastinum: cut surface of a mediastinal, white mass that involves the esophagus. (**4**) Case 2, kidney: a large white mass (3 × 2 cm) expands and replaces the renal parenchyma. (**5**) Case 2, esophagus: highly anaplastic round cells in the submucosa exhibit multinucleation and karyomegaly. Anaplastic, round neoplastic cells efface the lamina propria and are occasionally seen inside blood vessels. The overlying esophagus epithelium is seen in the top-left corner. HE, obj. 20x. (**6**) Case 2, esophagus: the neoplastic cells have moderate membranous and cytoplasmic immunolabeling for IBA-1, obj. 20x.

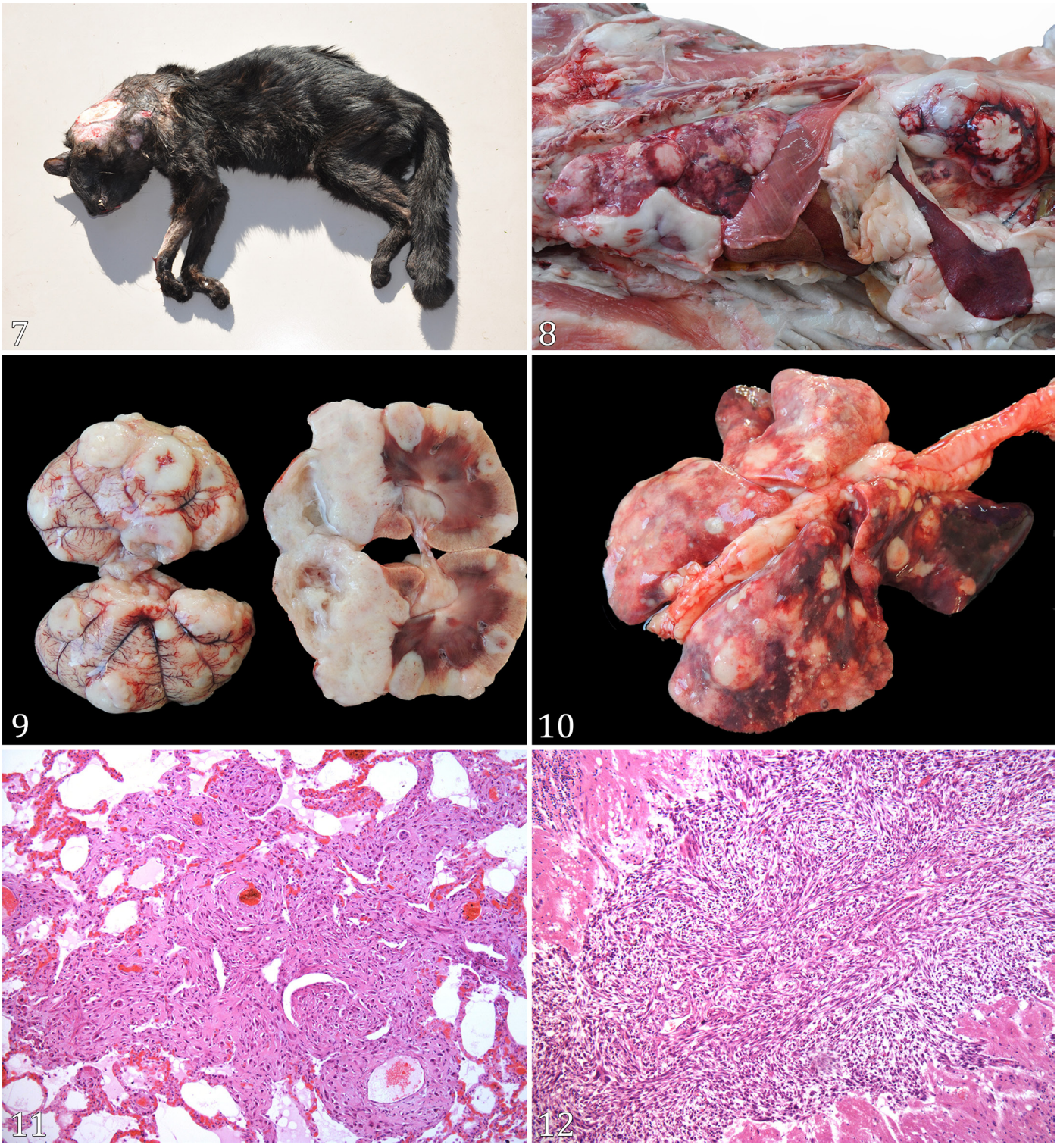

Fig. 7-12. Gross and histological features of metastatic feline injection site sarcomas (FISS) in cats. (**7**) Case 4, skin: there is a large subcutaneous mass in the interscapular and cervical region. (**8**) Case 6, lung and kidney involvement: multiple white to red nodules are observed in the lungs and left kidney. (**9**) Case 6, kidneys: multifocal to coalescing white nodules of various sizes in both kidneys, which efface the cortex and medulla and eventually have umbilicated centers. (**10**) Case 6, lungs: multiple randomly distributed white nodules affecting all lung lobes. (**11**) Case 4, lungs: spindle-shaped neoplastic cells arranged in multiple bundles in a densely collagenized matrix obliterate the alveolar spaces and are intimately associated with blood vessels. HE, obj. 20x. (**12**) Case 6, cerebellum: metastatic neoplastic spindle cells infiltrate and disrupt the adjacent neuropil. HE, obj. 20x.

multiple, firm, white nodules of 0.5 x 1 cm. Case 5 had an 8 x 6 x 0.2 cm ulcerated soft tissue tumor that expanded the subcutaneous tissues of the lumbar region and extended along the left thoracic wall. On the cut surface, large, friable areas of necrosis were observed. Pulmonary metastases were characterized by pinpoint, multiple, firm, white nodules of 1–1.5 cm in multiple lung lobes. Case 6 had a poorly defined mass in the subcutis in the right scapular region, which involved the adjacent connective tissue and skeletal muscle. The lesion measured 10 x 8 x 6 cm without bone infiltration. On the cut surface, it was white with a cystic center containing mucinous fluid. Pulmonary metastasis appeared as multiple round white pinpoint areas in all lung lobes. Right hindlimb amputation was performed in Case 7 to treat a sarcoma previously diagnosed by cytology. At necropsy, metastatic sites included intercostal musculature, cerebellum, spinal cord, both kidneys, and lungs (Fig. 8-10).

Histologically, Cases 4, 5 and 7 had a histologic pattern of fibrosarcomas, which was well-differentiated and composed of spindle-cells arranged in multiple interwoven bundles on primary and metastatic sites (Fig. 11-12). Peripheral inflammation of lymphocytes and zones of necrosis were consistently present. Mitotic count was high in all three cases (12, 11 and 8 in 2.37 mm^2, respectively). At IHC, these cases were all negative for desmin and α-SMA, which excluded a myofibroblastic phenotype. Additionally, S100 was negative, making a neural or melanocytic origin unlikely. Case 6 revealed spindle-shaped neoplastic cells arranged in interwoven bundles, which occasionally produced osteoid matrix mineralization. Adjacent inflammation and zones of necrosis were present, and the mitotic count was seven in 2.37 mm^2. Based on the histologic criteria, all four cases were classified as grade III according to Dobromylskyj et al. (2021). Additionally, in all cases (Cases 4, 5, 6 and 7), the neoplastic cells showed marked, multifocal cytoplasmic immunolabeling for vimentin and did not express IBA-1, excluding feline giant-cell pleomorphic sarcoma.

Visceral spindle cell sarcomas

Visceral spindle cell sarcomas were diagnosed in three of 12 cases (25%), characterized by neoplastic involvement of multiple visceral organs and absence of cutaneous involvement. Primary disease in Case 8 was suspected to have arisen from the urinary bladder based on first clinical manifestation and gross appearance at necropsy (Fig. 13). The gross findings in Case 8 included multifocal to coalescing, white nodules ranging 2.0–3.0 cm in diameter that expanded the urinary bladder mucosa, kidneys, lungs, liver, adrenal, and medial iliac lymph nodes (Fig. 14-15). The primary site in Cases 9 and 10 was suspected to be the esophagus. Case 9 had a friable, white mass in the caudal portion of the esophagus (Fig. 16), and pulmonary lesions were characterized by pinpoint, white foci ranging 0.2–0.5 cm in diameter. Case 10 had a white mass of 11 x 6 cm in the caudal portion of the esophagus, and the lungs had rare white nodules up to 1 cm in diameter. Histologically, Cases 8 and 9 exhibited highly pleomorphic neoplastic cells, ranging from spindle-shaped to ovoid to polygonal, arranged in bundles. Anisokaryosis and anisocytosis were severe, and the mitotic counts were 10 and 7 in 2.37 mm^2, respectively. A final diagnosis of a poorly differentiated (anaplastic) sarcoma was reached (Fig. 17). Case 10 was morphologically compatible with myxosarcoma (Fig. 18), composed of spindle to stellate cells loosely arranged in a basophilic matrix. The lack of α-SMA and desmin expression excluded myofibroblastic differentiation, and negative S100 immunolabeling ruled out neural and melanocytic origin. In all three cases, the neoplastic cells showed marked, multifocal cytoplasmic immunolabeling for vimentin, confirming their mesenchymal origin.

Hemangiosarcomas

Hemangiosarcomas comprised 16.7% of diagnoses in our study, with 2/12 cases. Macroscopically, Case 11 showed dark red to black nodules, ranging 0.1–3.0 cm in diameter, in the subcutaneous tissues of abdominal mammary glands, skeletal muscles, omentum, kidneys, lungs, heart, pancreas, brain, spleen, and liver (Fig. 19). Lymph nodes (superficial cervical, axillary, inguinal, mandibular, sternal, tracheobronchial, cranial mediastinal, hepatic, gastric, pancreaticoduodenal, and medial iliac) were enlarged and red. Multifocal, red nodules involving the telencephalon, diencephalon and cerebellum were observed (Fig. 20). The subcutaneous tissue was considered the primary site in this case.

In Case 12, the colon was suspected to be the primary site, with an infiltrative, dark red, fluctuant, intramural mass compressing the lumen and infiltrating into the mesenteric lymph node (Fig. 21). Neoplasm was also observed in the liver, which was characterized by dark red and white fluctuating masses measuring up to 2 cm in diameter (Fig. 22). The cause of death was a massive hemoperitoneum secondary to tumor rupture. Histologically, both cases exhibited neoplastic endothelial cells arranged in irregular, blood-filled spaces, with adjacent areas of hemorrhage (Fig. 23-24).

DISCUSSION

Multicentric or metastatic sarcomas are rare in cats; mature adults and senior cats were most commonly affected by sarcomas in our study, suggesting that age is a risk factor for these neoplasms. The clinical survival was highly variable in the cats, ranging from two to 240 days, but conclusions cannot be drawn from the clinical data, as almost all individuals were euthanized.

Histiocytic sarcomas (HS) are neoplasms of interstitial dendritic cells and occur as multiple masses in multiple organs, most frequently affecting dogs (Affolter & Moore 2002). Three cats in this study had lesions similar to those described in disseminated histiocytic sarcomas in dogs, with multiple tumor masses in several organs (Affolter & Moore 2002). In cats, the most commonly affected sites in this study were the lungs, kidneys, skin, and lymph nodes, which are frequently described sites in dogs (Affolter & Moore 2002, Moore 2017), suggesting similarity of the disease between the two species. Furthermore, the ocular involvement observed in Case 3 was similar to that described in previous studies, demonstrating that the ciliary body and iris may serve as metastatic or multicentric sites for disseminated histiocytic sarcoma in cats (Bandinelli et al. 2020), similarly to the heart, which has also been reported as a site of metastatic disease in a case of periarticular histiocytic sarcoma in a cat (Chalfon et al. 2021).

In cats, disseminated histiocytic sarcoma (DHS) needs to be distinguished from late-stage Langerhans cell histiocytosis

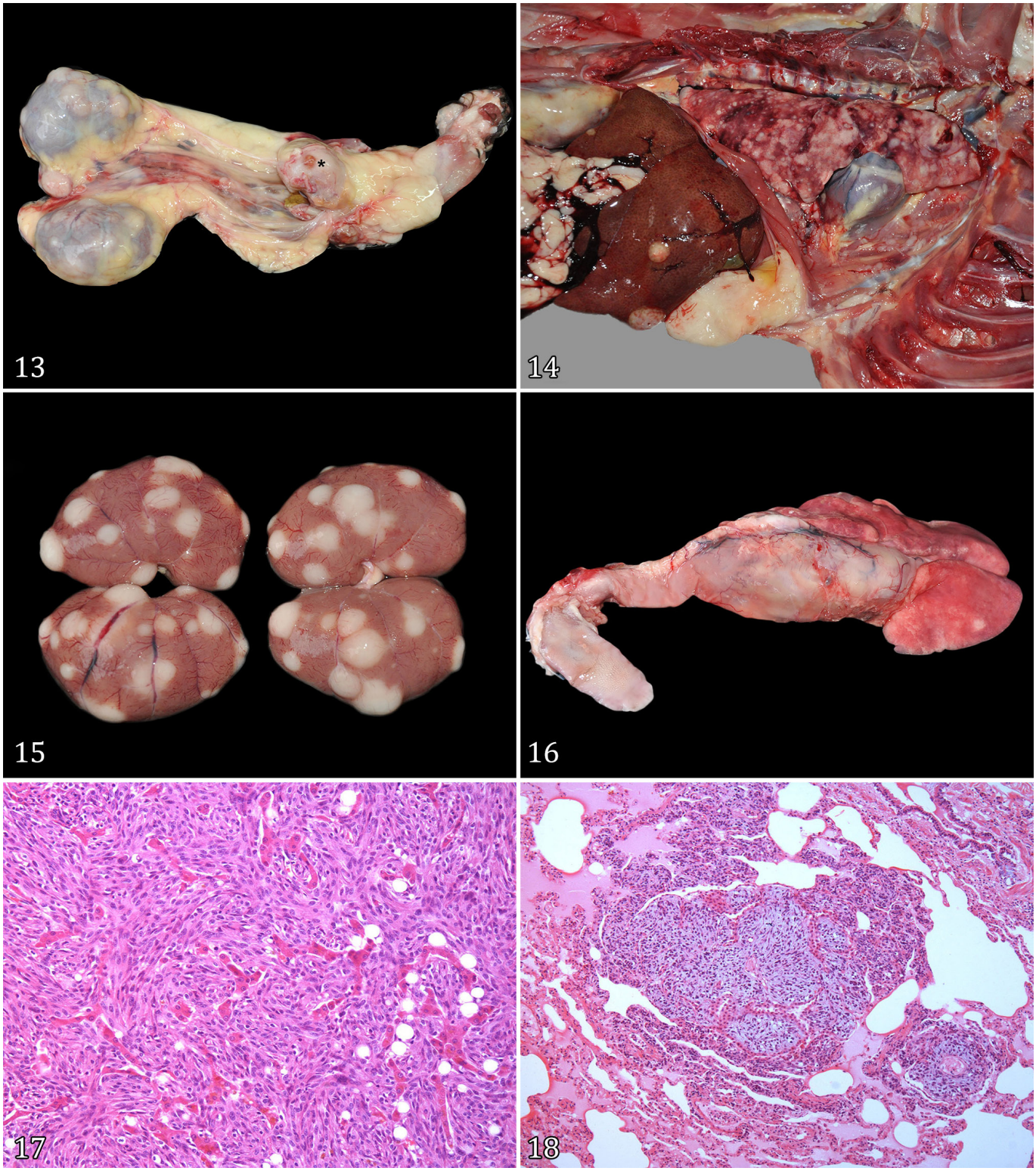

Fig. 13-18. Gross and histological features of visceral spindle cell sarcomas in cats. (**13**) Case 8, kidneys and urinary bladder: the urinary bladder is diffusely distended (asterisk). Both kidneys are enlarged and contain multiple nodular formations. (**14**) Case 8, lung and liver: multifocal white nodules in the liver measure up to 3 cm in diameter. Similar nodules are seen in the lungs and occasionally coalesce. (**15**) Case 8, kidneys: multifocal white nodules on the capsular surface affecting both kidneys. (**16**) Case 10, mediastinum: there is a white mass affecting the cranial mediastinum. A single white nodule can be seen in the left caudal lung lobe. (**17**) Case 8, liver: neoplastic spindle cells efface the hepatic cords and dissect through atrophic hepatocytes. HE, obj. 20x. (**18**) Case 10, lung, metastatic myxosarcoma: neoplastic stellate to fusiform cells with abundant amorphous basophilic extracellular matrix expand the alveolar spaces. HE, obj. 20x.

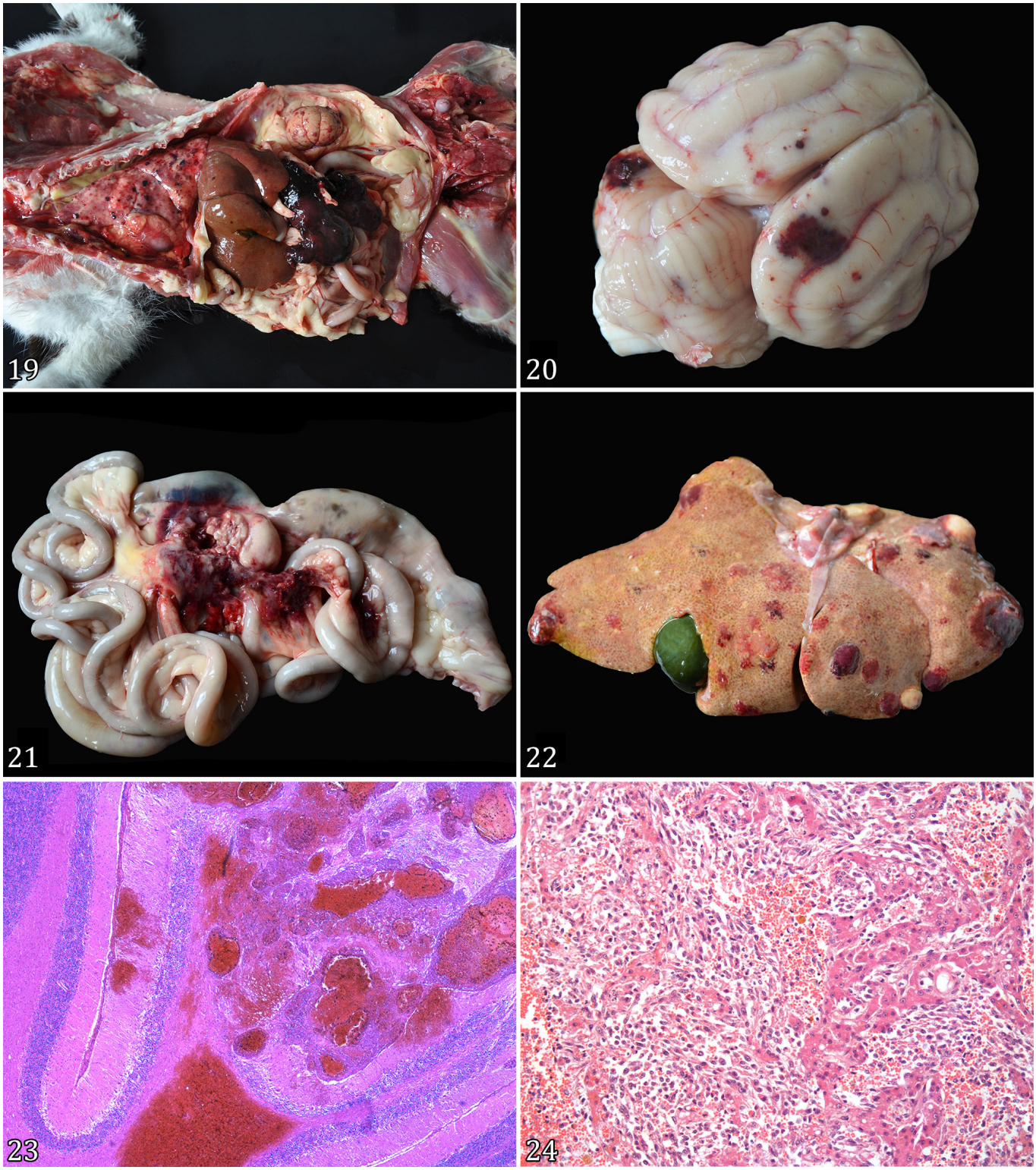

Fig. 19-24. Multicentric hemangiosarcoma in two cats. (**19**) Case 11, multiple organ involvement in the thoracic and abdominal cavities. There are multifocal, red, pinpoint-to-nodular areas in the lungs, liver, kidneys, and spleen, measuring up to 1.5 cm in diameter. (**20**) Case 11, brain: there are multifocal red nodules in the cerebellum and telencephalon. (**21**) Case 12, colon and mesenteric lymph node: metastatic colonic hemangiosarcoma. An infiltrative, dark red mass that effaces the mesenteric lymph node. (**22**) Case 12, liver: there are multifocal red and white nodules in all hepatic lobes measuring up to 2 cm. (**23**) Case 11, cerebellum: the neoplastic cells are in small groups and form irregular blood-filled vessels (top right corner), and severe multifocal to coalescent hemorrhage obscures the neoplastic cell proliferation. HE, obj. 20x. (**24**) Case 12, liver: the neoplastic cells dissect through the adjacent hepatocytes and form blood-filled spaces. HE, obj. 40x.

(LCH) and feline progressive histiocytosis (FPH) (Moore 2017). However, features such as rapid clinical progression, whitish masses in multiple organs, and pleomorphic multinucleated cells supported the diagnosis of SH in our cases.

The low incidence of metastatic FISS found on our database is consistent with its biological behavior. These are locally invasive neoplasms, but with a low incidence of metastasis (Hartmann et al. 2015). Previous studies on subcutaneous soft tissue sarcomas rarely verify metastatic disease histologically. Metastases, therefore, appear uncommon; however, some earlier studies have suggested metastatic spread in a subset of cases, though this has not been histologically confirmed, and the main metastatic sites remain poorly characterized. A study on subcutaneous soft tissue sarcomas in cats did not histologically assess metastatic disease, and information regarding the principal metastatic sites remains scarce (Dobromylskyj et al. 2021). Only a few histologically confirmed metastatic cases have been reported, affecting the mediastinum, regional lymph nodes, liver, and lungs (Esplin & Jaffe 1997, Rudmann et al. 1996, Sandler et al. 1997).

A recently published study evaluated the prognostic value of the histologic grading of cutaneous and subcutaneous feline soft tissue sarcoma (Dobromylskyj et al. 2021). These authors concluded that the proposed grading system for cats had a significant correlation with overall survival. Nonetheless, the study did not differentiate between FISS and soft-tissue sarcoma unrelated to injection. There is a tendency for FISS to be high-grade due to the high degree of inflammation and necrosis; thus, the prognostic significance of this classification, including metastatic potential, is not apparent for FISS and is not necessarily related to tumor histomorphology (Martano et al. 2011).

Fibrosarcomas in cats may also be induced by feline sarcomavirus (FeSV), which is considered a defective mutant of FeLV capable of capturing cellular proto-oncogenes, such as v-fms (Barbacid 1981). However, in the only FeLV-positive case (Case 3), the diagnosis was histiocytic sarcoma, which did not exhibit the spindle-cell morphology expected in FeLV/FeSV-induced fibrosarcomas. Furthermore, these virally induced lesions are typically multicentric, located within the subcutaneous tissue in the skin, affect multiple anatomical sites, and are generally not associated with injection sites, findings that were not observed in Case 3. Furthermore, it was not possible to determine the involvement of the virus within the tissue in this case through complementary techniques such as in situ hybridization.

Visceral sarcomas are very rare in cats and have been reported in only a few case reports (White et al. 2020, Bonazzi et al. 2021, Hixson et al. 2022). Therefore, no definitive conclusions can be drawn, and further studies are needed to better categorize these tumors with regard to their predominant phenotype and the main organs involved.

Hemangiosarcoma in cats is most often multicentric at the time of diagnosis (Culp et al. 2008). In the present study, the two hemangiosarcomas were considered to be located in the colon and subcutaneous tissue; however, it is difficult to determine, conclusively, whether these sites were primary. On the other hand, the intestines are among the most commonly described primary sites of visceral hemangiosarcomas in cats (Sharpe et al. 2000, Culp et al. 2008), typically metastasizing to the mesenteric lymph nodes (Sharpe et al. 2000), as observed in our case (Case 12).

Visceral and subcutaneous hemangiosarcomas occur at very similar frequencies, with the former being more likely to metastasize (Scavelli et al. 1985). However, subcutaneous hemangiosarcomas are also considered to have metastatic potential (Johannes et al. 2007), as seen in Case 11. This cat (Case 11) was first referred for clinical examination due to a mammary subcutaneous mass two months before the necropsy. The thoracic radiograph findings at that time were unremarkable, suggesting a primary subcutaneous hemangiosarcoma at the time of necropsy. Still, chest radiography may lack the sensitivity to detect small metastatic lesions, and more sensitive imaging techniques may be necessary. Hence, necropsy was useful in confirming the involvement of multiple organs, including pulmonary involvement that was not seen at the first appointment. Furthermore, cerebral metastases were detected in this cat, a finding reported in subcutaneous hemangiosarcoma (Tudor & Greenlee 1994). This case indicates the potential for cranial metastasis of subcutaneous hemangiosarcoma. Both cats in our study developed liver metastases, suggesting that the liver is commonly affected by hemangiosarcoma in cats.

CONCLUSION

This study shows that diseases classified under "metastatic or multicentric sarcomas" are very rare in domestic cats and comprise different diseases with variable clinical manifestations, such as histiocytic sarcomas, feline injection-site sarcomas, visceral spindle cell sarcomas and hemangiosarcomas. The main affected sites were the lungs, kidneys, skin, and regional lymph nodes. Grossly, the findings were highly variable, ranging from multifocal pinpoint white foci to nodules and large masses. This wide macroscopic variation highlights the importance of thorough necropsy examination to detect subtle lesions and identify small or microscopic metastatic foci.

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Data availability statement.- The data used in this study are available and can be accessed upon request to the corresponding author.

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