A 15-year-old female goat that had been housed on the same property for 10 years was brought to the Cornell Equine and Food Animal Hospital for evaluation. The goat’s vaccination status was current, and it underwent regular deworming. During the preceding 2 years, the goat had slowly lost weight and was intermittently anemic. Anemia was presumed due to internal parasitism, and deworming was performed as needed on the basis of fecal egg counts and mucous membrane color. One week prior to the evaluation, anorexia and increased weight loss were noted; persistent lethargy and diarrhea developed. Two days prior, the goat was observed to have difficulty breathing and had markedly pale mucous membranes. Treatment with oxytetracycline was initiated, but the goat’s condition continued to deteriorate and it died en route to the hospital.

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**Figure 1**—Photograph of the abdomen of an aged goat that died after slow weight loss and intermittent anemia during the preceding 2 years, with anorexia, increased weight loss, lethargy, and diarrhea of 1 week’s duration and respiratory distress of 2 days’ duration. The goat died during transport for evaluation. Notice the thickened mesentery and nodules on the abdominal wall and large quantity of abdominal fluid. The body is in left lateral recumbency with the cranial aspect to the right and caudal aspect to the left.

**History**

Because the goat died before initial evaluation, no antemortem tests were performed. The goat weighed 58 kg (127.6 lb). On gross examination, the abdominal cavity contained approximately 7 L of thin, red, slightly cloudy fluid. The omentum, abdominal wall, abdominal surface of the diaphragm, and urinary bladder were covered with hundreds of red-tan, firm, smooth nodules (1 to 20 mm in diameter) that extended into the serosal surface of the urinary bladder and uterus. The liver, lungs, myocardium, and right kidney contained similar small nodules throughout the parenchyma. The uterus was enlarged and firm with a red-gray mottled friable mass filling the uterine lumen. Each adrenal gland contained a tan medullary nodule measuring approximately 0.5 cm in diameter.

Additional gross findings included kidneys of dissimilar size: the left kidney (3 X 2 X 2 cm) was dramatically smaller than the right (6 X 3 X 3 cm). The left renal pelvis was dilated and contained a moderate amount of brown, gritty material. The remaining parenchyma of the left kidney was markedly compressed and firm (fibrosis). A cyst was present on the left thyroid gland.

Formulate differential diagnoses from the history, clinical findings, and Figure 1—then turn the page →
Histopathologic Findings

Samples of the uterus, adrenal glands, kidneys, heart, thyroid glands, urinary bladder, liver, spleen, skeletal muscle, rumen, lungs, small and large intestines, pancreas, brain, and pituitary gland were examined histologically. The serosal surfaces of multiple organs including the uterus and urinary bladder and the parenchyma of the adrenal glands, lungs, myocardium, and liver were multifocally infiltrated by a population of spindle-shaped neoplastic cells arranged in streams and bundles (Figure 2). Neoplastic cells had moderate amounts of finely stippled cosinophilic cytoplasm and large nuclei with vesiculated chromatin and 1 to 3 prominent nucleoli. Anisocytosis and anisokaryosis were moderate with occasional multinucleate cells. The mitotic rate was low at 1 to 2 mitotic figures/10 hpfs (400X). Multifocally, throughout the neoplasm, there were moderately sized areas of necrosis with scattered neutrophilic aggregates. Neoplastic cells had diffuse strong cytoplasmic immunoreactivity for both cytokeratin intermediate filaments and vimentin intermediate filaments (Figure 3).

Examination of the thyroid gland revealed a large colloid-filled cyst, which was considered an incidental finding. The left kidney was dramatically fibrotic with lymphoplasmacytic interstitial nephritis and multiple cystic dilations. The cause of renal fibrosis was not apparent, but it was interpreted as most likely secondary to previous unilateral nephritis. On the basis of the neoplastic cells' location, predominantly spindle morphology, and immunohistochemical pattern, a diagnosis of sarcomatoid mesothelioma was made.

Morphologic Diagnosis and Case Summary

Morphologic diagnosis: peritoneal mesothelioma with metastasis to adrenal glands, heart, and lungs.

Case summary: peritoneal mesothelioma with distant metastasis in an aged goat.

Comments

Mesothelioma is an uncommon disease in domestic animals. In a recent

Figure 2—Photomicrograph of a section of the neoplastic cells from the urinary bladder serosal surface of the goat in Figure 1. Neoplastic cells are spindle to plump and have formed interlacing streams with moderate anisocytosis and anisokaryosis. There is slight festooning of neoplastic cells at the surface of the bladder. H&E stain; bar = 100 µm.

Figure 3—Photomicrographs of sections of neoplastic cells from the urinary bladder of the goat in Figure 1 following immunohistochemical staining for cytokeratin (A) and vimentin (B). Notice the strong, diffuse immunopositivity for both cytokeratin and vimentin throughout the neoplastic cell population. Because immunohistochemical analyses require the use of different chromogens for these markers, cytokeratin-positive cells appear red (A), whereas vimentin-positive cells appear brown. Cytokeratin- or vimentin-specific immunohistochemical stain; bar = 50 µm.
review of 102 tumors in 100 goats, none of the examined animals had mesothelioma. Mesotheliomas may originate from any mesothelial cell-lined surface, including the peritoneum, vaginal tunic of the testis, pleura, and pericardium. Primary tumors in any of these body cavities can metastasize to multiple locations. These neoplasms are often accompanied by extensive serous effusions secondary to obstructed lymphatics or tumor exudation. This fluid accumulation promotes exfoliation and implantation of neoplastic cells, with metastasis most commonly occurring by local implantation rather than distant metastasis; however, invasive mesotheliomas with widespread dissemination have been reported.

In animals with mesothelioma, clinical signs are variable but include lethargy, weight loss, respiratory distress, and abdominal and thoracic effusions. Results of cytologic evaluation of samples of cavity effusions are helpful for diagnosis; however, given the difficulty in distinguishing reactive mesothelial cells from neoplastic mesothelial cells, making a definitive cytologic diagnosis is challenging. A recent case report documented the ultrasonographic findings of abdominal mesothelioma in a goat, but similar to the case reported here, a definitive diagnosis to rule out carcinomatosis required histologic evaluation. In that other case, ultrasonographic findings included detection of hypoechoic abdominal fluid and multiple nodular lesions throughout the abdomen. In goats, other causes of abdominal effusion that must be ruled out include intestinal adenocarcinoma, uroperitoneum, and hypoproteinemia secondary to parasitism.

The etiopathogenesis of mesotheliomas in domestic animals is not well understood. In humans, thoracic and abdominal mesotheliomas are associated with exposure to asbestos, and a similar relationship in dogs has been reported. In cattle, a congenital association has been suggested. Mesotheliomas of the thoracic, abdominal, and pericardial cavities in neonatal calves have been described. Reports of mesotheliomas in goats are rare and include case reports of 2 abdominal mesotheliomas and 1 thoracic mesothelioma. In none of those cases was distant metastasis detected. Mesotheliomas in other domestic animals are considered rare with occasional reports of affected sheep, horses, goats, cats, a leopard, and rabbits.

Histopathologic diagnosis of mesothelioma is based on tumor distribution, cellular morphology, and patterns of immunohistochemical staining. Mesotheliomas have variable morphology and are classified as epithelioid, sarcomatoid, or biphasic. Epithelioid mesotheliomas are composed of polygonal cells and resemble carcinomas, sarcomatoid mesotheliomas are morphologically similar to fibrosarcomas with bundles and streams of spindle cells, and biphasic tumors are characterized by both spindle

and epithelioid cell populations. The sarcomatoid form is less common in domestic animals than the epithelioid form but is most consistent with the case described in the present report on the basis of the large population of spindle-shaped cells that formed streams and bundles. Mesothelial (neoplastic and normal) cells coexpress markers of epithelial (cytokeratin-positive) and mesenchymal (vimentin-positive) cells. A small number of neoplasms have this pattern of coexpression. These include synovial cell sarcoma, renal cell carcinoma, some meningiomas, ciliary body adenoma, some anaplastic carcinomas, some amelanotic melanomas, and Sertoli cell tumor. Differentiation of mesothelioma from these neoplasms is primarily based on the location and cellular morphology of the primary tumor.

For domestic animals with mesothelioma, prognosis is considered guarded to grave. In cases of localized mesothelioma, intracavitary chemotherapy may be of use; and successful treatment of an affected dog has been reported. Treatment of production animals with mesothelioma has not been reported, to our knowledge.

Acknowledgments

The authors received no financial support for this work.

References