Osteosarcoma in adjacent lumbar vertebrae in a dog

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- Vertebral osteosarcoma is an uncommon neoplasm. Affected dogs typically have neurologic signs consistent with spinal cord compression.
- New sensitive imaging methods may reveal tumor-associated changes not evident in routine radiographs, thus enhancing locoregional staging of disease.
- Metastatic lesions of osteosarcoma in adjacent bones may develop before there is radiographic evidence of pulmonary metastasis.

An 8-year-old sexually intact male Belgian Malinois was referred to the Military Working Dog Veterinary Service for evaluation of progressive caudal paresis of 2 to 3 weeks' duration. On physical examination, the dog was quiet and alert but had difficulty rising from the sitting position. The gait was mildly to moderately ataxic in the hind limbs during walking. Abnormal findings on physical examination were limited to the nervous system. Conscience proprioception was slightly abnormal in both hind limbs, and the patellar reflex was slightly decreased in the left hind limb. The right patellar reflex was judged to be normal, as was anal tone. Neurologic deficits affecting cranial nerves or the forelimbs were not detected. A pain response was not elicited by applying direct pressure along the spine or during hip extension.

Results of CBC, serum biochemical analyses, and urinalysis were within reference ranges. Serum **thyroxine (T_4)** concentration was decreased (0.4 µg/dl; reference range, 1.0 to 3.6 µg/dl), endogenous thyroid-stimulating hormone concentration was slightly increased (0.45 ng/ml; reference range, 0.1 to 0.4 ng/ml), and serum free T_4 concentration was equal to the lower limit of the reference range (0.7 ng/dl; reference range, 0.7 to 2.5 ng/dl), suggesting nonthyroidal illness or early hypothyroidism. Electrophysiologic studies were performed at the time of anesthesia for radiography as part of a routine workup of military dogs for central and peripheral neurologic disease. Median conduction velocities for tibial and ulnar nerves and electromyographic findings were within reference ranges. Radiographic examination of the spine revealed a mottled appearance to the body of L4, and the intervertebral foramen at L4-L5 appeared to be misshapen. Ventral spondylosis was detected at L1-L2 and L4-L5. Thoracic radiographs did not reveal any abnormalities of other skeletal or soft-tissue structures.

A myelogram was performed via administration of iohexol[a] (0.4 ml/kg [0.18 ml/lb] of body weight) at the cisterna magna. The dye column terminated within the spinal canal of L4, and the ventral column of dye appeared to deviate dorsally at termination (**Fig 1**). On the ventrodorsal view, the space occupied by the contrast media appeared to widen and encircle a density in the body of L4. Evaluation of CSF taken before injection of contrast media did not reveal abnormalities in protein or glucose concentration or cytologic findings. A **computed tomography (CT)** scan was performed at the local military hospital to evaluate L4 and adjacent vertebrae. Computed tomography of the spine, using 3-mm intervals from L3 to L5 for transverse images, revealed a soft-tissue mass adjacent to or involving the spinal cord and L4. There appeared to be complete destruction of a portion of the floor of the vertebral foramen at L4 (**Fig 2**). Small circular osteolytic lesions were also noticed within the cranial portion of the body of L3 (**Fig 3**) and the caudal portion of the body of L5. A left-sided hemilaminectomy was performed to relieve spinal cord compression and obtain a biopsy specimen. Proliferative soft tissue was observed on the floor of the spinal canal within L4, and the dura was intact at the surgical site. A section of the soft tissue mass was removed for histologic examination.

Histologic examination of the excised tissue revealed a high-grade sarcoma; differential diagnoses included malignant fibrous histiocytoma and osteogenic sarcoma. The patient improved neurologically for approximately 5 days after surgery and then became increasingly paraparetic. Euthanasia was chosen because of the poor prognosis associated with the tumor type and location. A complete necropsy was performed. Important gross necropsy findings were limited to the vertebral column. A firm plaque-like mass caused expansion of most of the floor of the spinal canal of L4 and mildly compressed the intact spinal cord above. Transverse sectioning of the body of L4 exposed an irregular cream-colored mass that replaced > 70% of the bone. Additional transverse sections revealed small (5- to 8-mm diameter) cystic or lytic areas within the bodies of L3, L5, and L6, separated by grossly normal bone and intervertebral discs. Gross lesions in L3 and L5 corresponded to the lesions identified by examination of CT images. Microscopic examination revealed separate foci of osteosarcoma in the third, fourth, fifth, sixth, and seventh lumbar vertebrae, the sacrum, and the lungs (**Fig 4**).

Primary osteogenic sarcoma of the spine is rare in humans and dogs. In several large studies in humans, prevalence of spinal-origin osteosarcoma ranged from 0.85 to 3.0%.[1] In studies of osteosarcoma in dogs, < 5%

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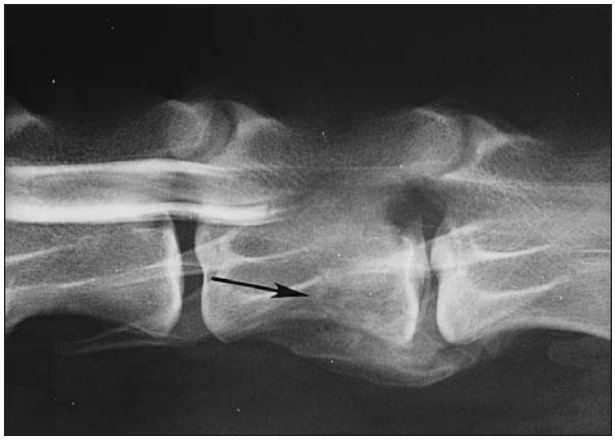

Figure 1—Lateral myelographic view of L3, L4, and L5 of a dog with osteosarcoma. Contrast material was injected at the cisterna magna; notice that caudal flow of the contrast material was completely obstructed in the cranial aspect of L4, and the dye column was deviated dorsally cranial to the obstruction. Mottled lucency (arrow) is evident in the body of L4.

Figure 2—Computed tomographic view of L4 of a dog with osteosarcoma. Notice permeative destruction of the vertebral body with destruction of the cortex forming the ventral aspect of the vertebral foramen.

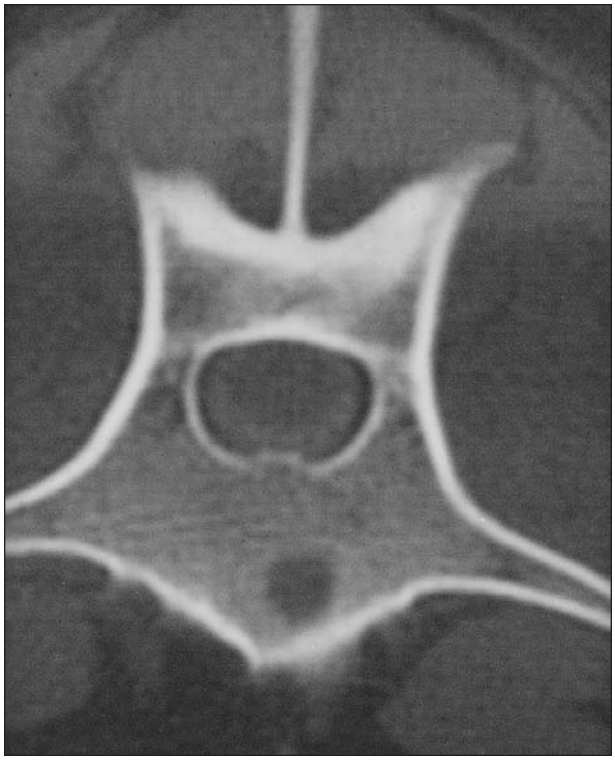

Figure 3—Computed tomographic image of the cranial aspect of L3 in a dog with osteosarcoma. Notice the 5-mm lytic lesion in the body of the vertebra.

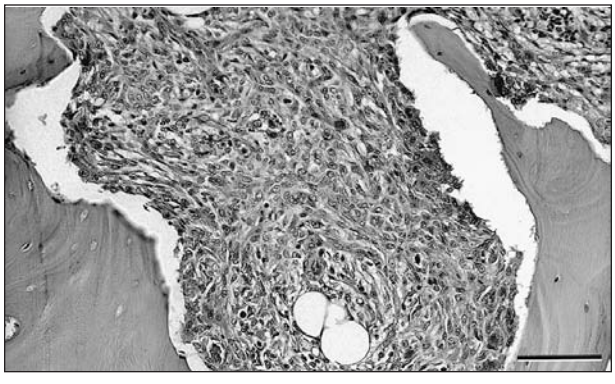

Figure 4—Photomicrograph of a section of an osteosarcoma in the vertebral column of a dog. The section was obtained from the margin of a lytic lesion in the body of L5. Notice the densely packed and irregularly arranged plump spindle cells that extend into the marrow space of the adjacent bone. Osteoid

of reported cases developed in the vertebral column,[2-5] although the ratio of axial skeletal osteosarcoma to appendicular skeletal osteosarcoma increases as the size of the dog increases.[6]

Diagnosis of the lesion in our patient was originally made on the basis of routine radiographic findings. Conventional radiography is the keystone to diagnosis of bone lesions,[7] but 50 to 60% of vertebral body bone mass must be destroyed before a lesion becomes evident on routine radiographs.[8] Newer methods of imaging are far more sensitive in identifying bone destruction in primary and metastatic sites. Although radiographic bone surveys and nuclear scintigraphy are considered valuable staging tools in veterinary medicine,[7,9-11] CT and magnetic resonance imaging are the procedures of choice in locoregional staging of bone cancer in humans.[12] Magnetic resonance imaging is considered more accurate than CT in defining the extent of medullary tumor and may detect lesions not revealed by conventional radiography, bone scintigraphy, or CT.[13]

In the dog reported here, routine radiography performed before myelography revealed lucency in the body of L4. Although most primary and metastatic

spinal tumors are lytic, many are proliferative or lytic and proliferative.[14] Although CT imaging of L4 revealed a proliferative and lytic osseous reaction, the survey radiographs of L4 and the CT images of adjacent vertebrae revealed lytic or cystic changes in the bones. Differential diagnoses for cyst-like expansile lesions of the body or processes of a vertebra include multiple myeloma, bone cyst, hemangioma, giant cell tumor, and osteosarcoma.[15] Histologic features of the initial biopsy specimen supported a diagnosis of high-grade sarcoma but did not provide clear evidence of osteoid production by the neoplastic spindle cells. On the basis of CT imaging alone, the appearance of multiple lucencies in the vertebrae was also suggestive of myeloma. Serum globulin concentrations within reference ranges and lack of proteinuria in this patient would not necessarily rule out multiple myeloma if the tumor burden was small.

Because extra-compartmental extension by vertebral body sarcomas commonly results in spinal cord compression, treatment of vertebral body neoplasia is often undertaken under nonelective conditions by use of limited tumor resection. As in the dog reported here, surgical decompression may be beneficial, but only for a limited time. Although it is not surprising that the prognosis is extremely poor, there is little information in the literature to suggest that spinal osteosarcoma is more malignant than appendicular osteosarcoma.[1]

Metastatic lesions in adjacent bones have been termed skip metastases. Skip metastases are secondary small foci of osteosarcoma that are anatomically separate from the primary lesion and found in the same bone or on the opposing side of an adjacent joint, rather than in distant portions of the skeleton. The primary tumor is typically in long bones, which is consistent with the normal distribution pattern of osteosarcoma. At the time of initial diagnosis, concurrent skip metastases and pulmonary metastases are uncommon, although lung metastasis may develop later.[16] Skip metastases are considered systemic metastases and prognosis associated with them is similar to or even graver than that of pulmonary metastases.[17]

Osteosarcomatosis, also known as multifocal osteosarcoma, refers to a condition in humans in which multiple intraosseous foci of osteosarcoma are evident at time of initial evaluation. Some investigators suggest that osteosarcomatosis represents multicentric primary neoplasia, whereas others suggest that osteosarcomatosis represents rapidly progressive metastatic spread to other skeletal sites.[18] Although multicentric osteosarcoma at the time of initial diagnosis has been reported in < 10% of dogs with osteosarcoma, the appendicular skeleton was the sole location for all tumors in the 4 documented cases in that study.[9]

In multifocal osteosarcoma and osteosarcomatosis, the mechanism responsible for the rapid appearance of secondary lesions in the axial skeleton without radiographic evidence of pulmonary metastases is not clear. Skeletal tumors metastasize most commonly via the hematogenous route.[7] The vertebral venous plexus, a set of valveless vessels that carry blood under low pressure, is a proposed route of metastasis to the axial skeleton, because the vertebral venous system parallels, connects with, and provides bypasses for the portal, pulmonary, and caval systems of veins. Increased intraabdominal pressure, as occurs with straining or coughing, may collapse the vena cava and cause venous flow to be diverted into the vertebral sinus system.[19-20] Spread of prostatic carcinoma to the vertebrae may also occur via this route.[21]

Sensitive imaging methods such as CT may enhance staging of neoplastic disease by revealing tumors and tumor-associated changes not evident on routine radiographs. In the dog reported here, a diagnosis of osteosarcomatosis of axial origin was supported by the finding of multiple foci of osteosarcoma with a radiographically dominant lesion at the time of initial evaluation. The unusual finding of distinct foci of osteosarcoma within 5 adjacent lumbar vertebrae and the sacrum is also consistent with skip metastases, potentially spread via the vertebral venous plexus.

[a]Omnipaque 300, Nycomed, Princeton, NJ.

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