A 10-year-old female spayed Dalmatian was evaluated for progressive cervical scoliosis and stiffness. This imaging report describes the imaging and postmortem findings for this patient. A diagnosis of an atypical manifestation of diffuse idiopathic skeletal hyperostosis (DISH) was made based on imaging and additional diagnostics. This report serves to increase awareness of DISH in the veterinary community, as well as to describe a unique presentation of the disease with atypical lesion distribution and severity. In addition, this report contrasts the pathophysiology and imaging characteristics of DISH with spondylosis deformans, which can appear comparable radiographically.

Key words: CT, extracortical ossification, hyperostosis, spondylosis deformans.

Signalment, History, and Clinical Findings

A 10-YEAR-OLD FEMALE spayed Dalmatian presented for a 1-year history of progressive cervical scoliosis and stiff gait. Mobility initially improved with oral corticosteroids, but 6 weeks later she fell without losing consciousness. At this time she was referred for further evaluation. Physical and neurological examination revealed a stiff, pacing gait in all four limbs without evidence of proprioceptive ataxia. Additionally there were postural reaction deficits in the right thoracic limb and the right and left pelvic limbs, moderate atrophy of left thoracic limb and epaxial musculature, and left-sided cervical scoliosis with limited cervical range of motion. Extensor tone was increased in the right thoracic limb (normal in the remaining limbs), withdrawal reflex was decreased in the right thoracic limb (normal in the remaining limbs), and the patellar reflex was increased in the right pelvic limb. Mild pain was elicited on palpation of the lumbosacral spine. These findings (right thoracic limb increased extensor tone with decreased withdrawal, right patellar hyperreflexia) indicated a lesion affecting the C6 – C8 spinal cord segments on the right side.
impaired and the owner elected euthanasia. Postmortem CT images of the vertebral column were acquired using a GE LightSpeed 8-multidetector helical CT scanner (General Electric, Fairfield, CT), followed by necropsy.

CT images revealed that the cortical margins and architecture of affected vertebral structures were maintained, and ossification appeared to be extracortical (Figs. 2 and 3). Moderate amounts of new bone surrounded vertebral arches and articular and spinous processes along the entire cervical and thoracic spine to the level of L₄, causing variably narrowed intervertebral foramina between C₃–C₇ (Fig. 2). There was mild peri-articular ossification at costovertebral joints and varying amounts of ossification along the ventral and lateral aspects of thoracic vertebral bodies, the most extensive bridging the T₁₀–T₁₁ disc space.

Lumbosacral osseous lesions were distributed along the ventral and lateral aspects of the L₂–S₁ vertebral bodies, forming bony bridges across intervertebral disc spaces. Dorsal structures caudal to L₄ were unaffected.

Cervical CT images also allowed evaluation of the proximal thoracic limbs. There was a large amount of extracortical ossification associated with both scapular spines and subscapular surfaces, and mild ossification at the lateral aspects of both humeral heads (Fig. 3).

Gross postmortem examination revealed severe bony proliferation that was especially pronounced over the dorsal aspects of multiple cervical vertebrae. Histopathology of the osseous lesions demonstrated chronic osseous proliferation without any evidence of neoplasia or osteomyelitis (Fig. 4). Histological findings in other organs included minor unrelated changes in the kidneys and lungs (membranoproliferative glomerulopathy, bronchiolar squamous metaplasia), but were otherwise unremarkable.

Using the diagnostic criteria in Table 1, the dog was determined to have an unusual manifestation of DISH. Fulfillment of four out of the first five criteria is sufficient to support this diagnosis. Criterion 2 was not fulfilled, as there was evidence of mild intervertebral disc degeneration at T₁₀–T₁₁, L₄–L₅, and L₅–L₆. Criteria 6 and 7 could not be evaluated due to the absence of pelvic imaging. Criteria 1, 3, 4, and 5 were all fulfilled, thus a diagnosis of an atypical DISH was established.
Diffuse idiopathic skeletal hyperostosis (DISH) is a disease of unknown etiology affecting the axial and appendicular skeleton of humans, dogs, and other species of mammals. Metabolic, endocrinological, genetic, and biomechanical factors have been implicated in the pathogenesis, and associations with diabetes mellitus and obesity in humans have been made. Diffuse idiopathic skeletal hyperostosis often remains clinically silent but can lead to spinal pain, stiffness, and in advanced stages spinal cord or nerve root compression and neurologic deficits.

In this report, we present a unique manifestation of DISH in a large breed dog. Diffuse idiopathic skeletal hyperostosis is relatively unknown in the veterinary community, gaining recognition only recently. The few reports that do exist in the veterinary literature mostly describe lesions similar to those found in humans, with flowing ossification and segmental bridging ankylosis along the ventral surface of vertebral bodies. In contrast, osseous lesions present in this patient predominantly affected dorsal vertebral structures, with relatively mild ventral lesions in the lumbar spine. All other differential diagnoses were ruled out based on negative serology for *H. americanum*, lack of historical vitamin A toxicosis (no known exposure to synthetic retinoids or diet with excessive vitamin A), as well as the character and histopathology of osseous lesions.

The characteristic flowing ossification of DISH with segmental bridging ankylosis along the ventral surface of vertebral bodies can appear similar to the radiographic appearance of spondylosis deformans, a noninflammatory bony response to intervertebral disc degeneration. Differences in lesion distribution and pathophysiology indicate that these syndromes are two separate entities. Diffuse idiopathic skeletal hyperostosis is a systemic disorder characterized by fibrocartilagenous proliferation followed by endochondral ossification within soft tissues of the axial and appendicular skeleton. Ossification of DISH appears to affect an area rather than specific anatomic structures, as it develops not only at entheses but also along the surfaces of ligaments, short fibers and in neighboring connective tissue, suggesting a possible biomechanical component to its poorly understood etiopathogenesis.

Disc degeneration and spondylosis are not thought to contribute to the development of DISH; however, these conditions all have higher prevalence with increasing age and may coexist. Potential coexistence of disc degeneration, spondylosis deformans and DISH in older dogs can confound the radiographic differentiation of the disorders. Close inspection is necessary to distinguish the conditions and recognize their coexistence, if present.

### Table 1. Diagnostic Criteria*, Morgan and Stavenborn (1991)

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<td>1. Flowing calcification and ossification along ventral and lateral aspects of three contiguous vertebral bodies leading to segmental bony ankylosis.</td>
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<td>2. Relative preservation of disc width within involved areas and absence of extensive radiographic changes of degenerative disc disease such as end-plate sclerosis, nuclear calcification, or localized spondylosis deformans.</td>
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<td>3. Peri-articular osteophytes surrounding true vertebral joints.</td>
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<td>4. Formation of pseudoarthrosis between the bases of the spinous processes.</td>
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<td>5. Peri-articular osteophytes and calcification and ossification of soft tissue attachments (enthesiophytes) in both axial and peripheral skeleton.</td>
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<td>7. Bony ankylosis of the symphysis pubis.</td>
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*Presence of 4 of the first 5 criteria is sufficient to support a diagnosis.
The criteria in Table 1 (also known as the “Morgan criteria”) have been accepted by many as the gold standard for the diagnosis of DISH in dogs, however, dispute over which diagnostic paradigm should be used in veterinary medicine still exists. The criteria in Table 2 (also known as the “Resnick criteria”) have long served as the mainstay of diagnosing DISH in humans, where lesions are typically most extensive in the anterior (ventral) spine. However, two past reports in dogs describe prominent dorsal lesions that deviate from the “classic” appearance, prompting the proposal of the Morgan criteria. Some state that the Morgan criteria are too strict, calling for a return to the Resnick criteria for the radiographic diagnosis of DISH in dogs in order to enhance our identification of the disease and support the “one medicine” concept.

Given the significant variation that may occur between humans and dogs with DISH in both lesion severity and distribution, it seems that both diagnostic paradigms have limited reliability when confronted with an atypical manifestation of the disease. The Resnick criteria emphasize “classic” ventral lesions, excluding potential extra-articular involvement of dorsal vertebral structures. The Morgan criteria offer wider lesion distribution, including dorsal vertebral and appendicular involvement; however, rigid inclusion requirement for four out of the first five criteria may exclude cases that are in fact DISH.

Ultimately the Resnick criteria appear to be reliable for diagnosing most cases of DISH in dogs, however in atypical cases (such as the one herein reported), the character and distribution of ossification may facilitate a diagnosis. Diffuse idiopathic skeletal hyperostosis should be suspected in any case of widespread extracortical, extra-articular ossification affecting entheses and soft tissues of the axial and/or appendicular skeleton.

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REFERENCES


