

Hypertrophic Pulmonary Osteoarthropathy in a Lioness (*Panthera Leo*)

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INTRODUCTION

Hypertrophic pulmonary osteoarthropathy (HPOA) is a condition in which long bone skeletal changes are associated with pulmonary lesions. The syndrome has been recognized in man, domestic animals and exotic animals. This disease was first described in 1891 when two cases of bronchiectasis associated with skeletal lesions in man were reported (2). The following year this entity was named hypertrophic pulmonary osteoarthropathy (10). Among animals, HPOA affects the dog (3) most commonly, but has been reported in a variety of other domestic animals including the horse (5, 8), ox (7), sheep (9), and cat (9). The literature contains several reports of HPOA in exotic species such as the orangutan (6), gibbon (12), deer (9), tiger (13), and lion (1, 4, 11, 14).

This paper describes the clinical, radiological, and pathological findings of HPOA in a lioness.

CASE HISTORY

The animal was a 25-year-old captive-born lioness who had resided at the National Zoological Park for 19 years and had given birth to 26 cubs. She had no known

major illnesses until one year prior to her death. During an episode of hemorrhagic cystitis, she was reluctant to initiate movement and appeared "a little stiff," with some lameness. The lameness was slowly progressive until two months prior to her death when she was observed to move with greater difficulty. Three ingrown claws were discovered on physical examination. The lioness was immobilized with 400 mg of CI-744⁷ delivered in a projectile dart by a CO₂ pistol⁸ and her claws were trimmed and the wounds treated topically. Palpation and manipulation of the legs and joints revealed no crepitation or limitation of movement. A systemic antibiotic⁹ was given. The results of a hemogram, including serum chemistry (SMA₁₂) taken at this time were within normal limits (Table).

Her lameness increased in the following weeks, but she ate well and appeared alert. Two months later she became anorectic and refused to move. The lioness was immobilized, as before, transported to the zoo hospital, and anesthetized with halothane and nitrous oxide to facilitate a radiological exam. Blood and urine samples were obtained and her legs were noted to be enlarged. There was no limitation or crepitation on movement of the joints.

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⁷ Parke, Davis & Co., Detroit, Mich.

⁸ Cap-Chur gun, Palmer Chemical & Equipment Co., Douglasville, Ga.

⁹ Bicillin, Wyeth Labs., Phila., Pa.

Table. Hemogram and Serum Chemistry (SMA₁₂) of Lioness Taken on Day of First Immobilization, 10/26/72 and on Day of Euthanasia, 1/4/73.

	10/26/72	1/4/73	Normal*	
			Mean	± Std. Dev.
Hematocrit (%)	38	37.5	40.5	± 1.7
RBC (10 ⁶ /cmm)		7.7	8.32	± .57
Hemoglobin (g/100 ml)	13.5		13.8	± .57
WBC (10 ³ /cmm)	14.9	24.6	12.5	± 3.0
Segments (10 ³ /cmm)	11.7	18.7	8.7	± 1.7
Bands (/cmm)	444	2,674	540	± 230
Lymphs (10 ³ /cmm)	2.1	1.0	2.6	± 1.1
Eosin (/cmm)	592	246	461	± 156
Total protein (g/100 ml)	8.0	6.4		
Calcium (mg/100 ml)	11.0	9.4	9.5	± 0.5
Phosphorus (mg/100 ml)	4.7	4.4	5.1	± 1.1
Glucose (mg/100 ml)	92	115	117	± 25
BUN (mg/100 ml)	54	19	66	± 9
Uric acid (mg/100 ml)	0.4	0.5	0.66	± 0.21
Cholesterol (mg/100 ml)	130	124	137	± 41
Bilirubin (mg/100 ml)	0.4	1.6	0.3	± 0.23
Alk. phosphatase (IU)	32	770	19	± 7
LDH (IU)	91	200	83	± 41
SGOT (IU)	37	87	39	± 9

* Baseline Laboratory Data for Captive Native and Exotic Species by U. S. Seal and D. G. Makey and Seamak Systems published by The American Association of Zoo Veterinarians.



Fig. 1. Lateral radiograph of hind limb. There are marked hypertrophic osseous changes with layered periosteal reaction almost at right angles to the shaft of the tibia. The outer contour of the periosteal reaction reveals a wavy pattern. At necropsy ossification in the soft tissue of the caudal aspect of the leg was found to be in the tendon.



Fig. 2. Dorsoventral radiograph of forepaw. Hypertrophic changes involve the metacarpals but not the terminal phalanges.

RADIOGRAPHIC EXAM

Radiographs revealed extensive hypertrophic changes of the periosteum (Fig. 1)

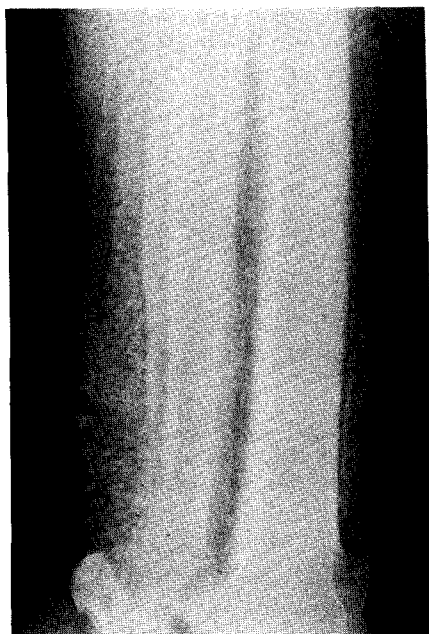


Fig. 3. Lateral radiograph of forelimb. In addition to the extensive hypertrophic periosteal changes, ossification of the tendon is present.



Fig. 5. Specimen radiograph of distal forelimb sectioned transversally. The concentric laminations surrounding the cortex of the radius and ulna are present as well as ossification in the soft tissues (flexor tendons).

Chest radiographs revealed densities in the basilar regions (Figs. 4A, 4B) which were consistent with chronic pulmonary disease.

Following the diagnosis of HPOA the lioness was euthanized and a necropsy con-

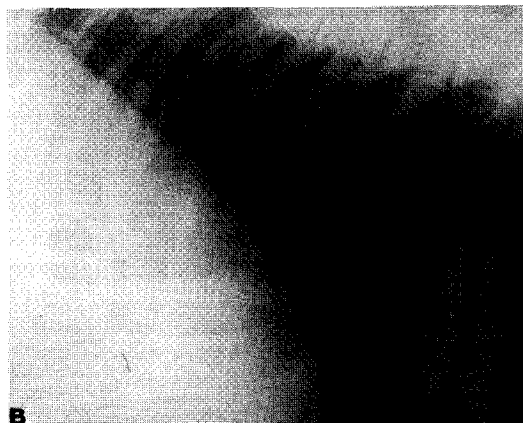
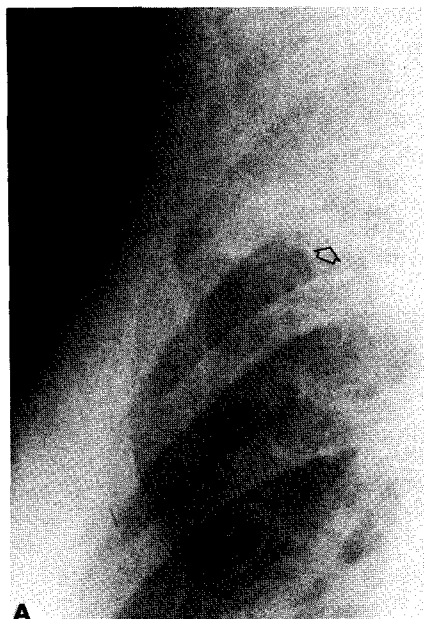


Fig. 4. Ventrodorsal (A) and lateral (B) chest radiographs (right lower lobe selective view). Linear densities in basilar regions (arrows) with irregular margins are consistent with chronic lung disease. These changes in lungs at necropsy proved to be primarily chronic bronchitis and emphysema.

which involved all of the appendicular skeleton except the distal phalanges (Fig. 2). In the soft tissues, the flexor tendons appeared mineralized; this was especially prominent in the distal forepaw (Fig. 3).

ducted. Post-mortem radiographs were also obtained (Fig. 5).

PATHOLOGIC CHANGES

The pertinent pathological changes were in the skeleton and the lungs. Grossly all

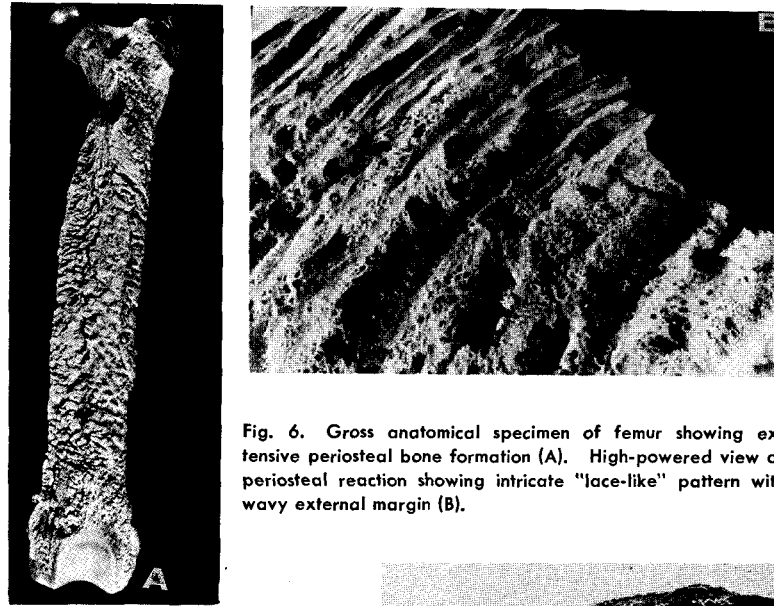


Fig. 6. Gross anatomical specimen of femur showing extensive periosteal bone formation (A). High-powered view of periosteal reaction showing intricate "lace-like" pattern with wavy external margin (B).



Fig. 7. Skull photograph. Hypertrophic changes are noted in the mandible (ventral surface) (arrow), occipital bone, zygomatic arch, and scattered over the surface of the calvarium (arrow) and facial bones.

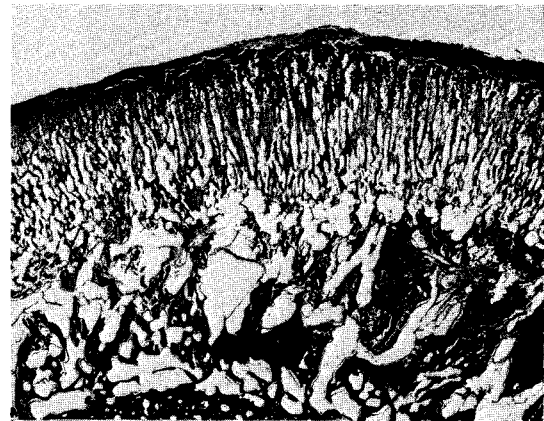


Fig. 8. Transverse section through cortex of humerus. Periosteum (top) is separated from cortical bone by thin trabeculae of new bone arranged perpendicular to the cortex (H&E X7).



Fig. 9. Transverse section through tendon of gastrocnemius muscle. A circumscribed area of osseous metaplasia containing fatty marrow is at the right (H&E X21).

four limbs were greatly increased in diameter distal to the elbow and hock joint. After exposure of the bones to dermestid beetles, lesions were observed in the bones of all four legs except the phalanges (Fig. 6A). The surfaces of the bones were roughened by coral osteophytes (Fig. 6B); many were confluent and encircled the entire bone except the articular surfaces. Exostoses also involved the mandibular rami, bone at the base of the skull (Fig. 7), and the wings of the ilium. Histologically

these deformities were produced by an extensive chronic proliferation of subperiosteal bone. Trabeculae and spicules of the bone were arranged perpendicular to the cortical surface as was evidenced by the radiographic appearance (Fig. 8). There was also focal dystrophic mineralization and metaplastic ossification of the flexor tendons (Fig. 9).

Grossly the lobes of both lungs contained emphysematous bullae, ranging in size from 2-10 cm., especially of the diaphragmatic lobes. Histologically chronic bronchitis and emphysema were the major lesions, with the primary bronchi containing copious amounts of mucopurulent exudate. This extended into the secondary bronchi and, in some instances, appeared to cause complete obstruction of some bronchi. The caudolateral quadrant of the left diaphragmatic lobe contained an 8-cm. circumscribed nodule; its cut surface was gray-white. The histologic appearance was that of a bronchiolar papillary adenoma.

Other pathologic findings included hepatic cysts caused by biliary ectasia and thecal cell tumor of the left ovary with luteal differentiation.

The superficial, mesenteric and hepatic lymph nodes were swollen and moist and on cut surface were cystic. Microscopically there was lymphadenovariex and efferent fibrosis.

DISCUSSION

Hypertrophic pulmonary osteoarthropathy was described in man over 80 years ago but its cause remains unknown. In animals it has been associated with chronic lung diseases, lung neoplasm, or space occupying lesions of the chest. The pathogenesis is not known, but the neurogenic theory is probably the most widely accepted. This hypothesis suggests that the bony lesions result from a reflex change in the regional vasculature which is mediated by fibers that travel in association with the vagus nerve. Regression of the lesion

has been attributed to the removal of the intrathoracic locus of stimulation for these impulses, and by sectioning the vagus nerve to disrupt the nervous impulses.

Clinical symptoms in man consist of bone pain which is acute at onset, deep-seated, burning in character and aggravated by lowering of the extremities or cold. Pain in the lioness was apparently severe, she was noted sleeping on her back with paws elevated. Whether or not this was an attempt to decrease pain is speculative since other normal large cats do sleep in this position.

Radiological features in man and animals consists of periosteal elevation associated with an overgrowth of highly vascular connective tissues. There is periosteal proliferation and new bone formation in a laminated pattern. Periosteal proliferation usually runs parallel to the length of bone and can be seen in musculotendinous insertions. The hypertrophic changes are most pronounced in the region of the peripheral epiphyses and are frequently better observed on the lateral margin, but our animal's extensive lesions were almost uniform in the involvement of the bone. Initially the layer of bone can be sharply distinguished from underlying cortical bone but, if this condition persists, the layer of new bone becomes part of the cortex. New bone, as in our animal, tends to have a wavy contour and to be separated from the old cortex by a thin radiolucent line.

Radiologically, in man, the differential diagnosis is a somewhat lengthy one, but the more common abnormalities that should be considered are: 1) syphilitic periostitis, 2) periostitis associated with venous stasis, 3) non-specific periostitis, 4) Caffey's disease, and 5) periosteal reaction with sickle cell disease. In animals, the differential is not so lengthy and the radiographic findings of multiple periostitis in the long bones is highly suggestive of HPOA. This finding would merit a radiographic examination of the chest.

Although a pulmonary adenoma was present in the lioness, the chronic pulmonary changes were probably more impor-

tant as the causative factor. Vagotomy was considered but was not attempted due to the advanced lung disease and general debility rendering the lioness a poor surgical risk.

The first case of HPOA in a lion was described 50 years ago. The primary disease was tuberculosis. There were extensive osseous lesions (4). The subsequent reports, except one, (11) in lions and tigers have all been associated with pulmonary TB.

The clinical pathological changes during the last 10 weeks are shown in the table. They include a leukocytosis with a neutrophilia and a "left shift" which are probably a reaction to the pulmonary lesions.

The marked increase in the alkaline phosphatase may be a reflection of the marked osteoblastic activity occurring at the site of the new subperiosteal bone formation. Until a specific bone isoenzyme is identified, however, one cannot be absolutely certain that the elevation is due to the bone lesion. The previous level of this enzyme is not elevated suggesting that many of the bone changes may have occurred very recently or that cyclic growth of the periosteal bone occurs and the initial sample was obtained during a relative inactive phase.

HPOA was not suspected in the lioness until the time of the radiographic examination. Prior to this her lameness was attributed to old age. As the lameness became worse it was again felt to be related to the animal's age and the ingrown claws. There were no clinical signs of respiratory disease noted at any time during her illness.

Until the time of her radiographs we did not consider the correct diagnosis, but feel that increased awareness of this disorder would have led to the proper studies earlier for its discovery.

SUMMARY

Hypertrophic pulmonary osteoarthropathy was diagnosed in a 25-year-old lioness by radiographic examination for a

chronic progressive lameness. There were no respiratory signs noted clinically.

Radiographic and pathologic examinations showed extensive periosteal proliferation of the long bones with extensive chronic lung disease. The lesions of HPOA were extensive and involved humerus, radius, ulna, femur, tibia, fibula, carpus, tarsus, metacarpals and metatarsal bones. Skull, mandible and pelvis were also involved.

Changes in the limbs also included ossification of the flexor tendons.

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ZUSAMMENFASSUNG

Ein Fall von hypertrophischer, pulmonarer Osteoarthropathie wurde in einer 25-jährigen Löwin durch radiographische Untersuchung für eine chronische progressive Lahmung diagnostiziert. Keine Anzeichen in der Atmung wurden klinisch festgestellt. Radiographische und pathologische Untersuchungen zeigten verbreitete periosteale Proliferation der langen Knochen mit ausgedehnter chronischer Lungenkrankheit. Die Schäden von HPOA waren ausgedehnt und befielen Humerus, Radius, Ulna, Femur, Tibia, Fibula, Carpus, Tarsus, Metacarpale und Metatarsale Knochen. Schädel, Unterkiefer und Becken waren

auch befallen. Zu den Veränderungen in den Gliedern zählte auch Ossifikation der Flechsen.

RÉSUMÉ

Un cas d'osteoarthropathie pulmonaire hypertrophique a été diagnostiqué chez une lionne de 25 ans par des radiographies pour une claudication chronique progressive. Aucun signes respiratoire n'était constatés par la methode clinique. Des examens radiographiques et pathologiques ont décelé une vaste prolifération du périoste des os longs avec une maladie pulmoninaire chronique étendue. Les lésions de l' HPOA étaient amples et impliquaient humérus, radius, cubitus, fémur, tibia, péroné, carpe, tarse, os métacarpiens et métatarsiens. La boîte crânienne, la mâchoire inférieure et le bassin étaient aussi impliqués. Des changements dans les membres comprennent aussi l'ossification des muscles fléchisseurs.