CARDIOPULMONARY DISEASE IN REPTILES

R. Schmidt, DVM, PhD, Dipl ACVP and D. Reavill, DVM, Dipl ABVP (Avian), Dipl ACVP*

Zoo/Exotic Pathology Service, 2825 KOVR Drive, West Sacramento, CA 95605 USA

ABSTRACT

This paper will cover the diseases of the cardiovascular and respiratory systems in reptiles. It is not intended as a comprehensive review. In-depth disease descriptions can be found in the references cited.

The paper is divided by etiologic disease categories involving the cardiovascular and respiratory systems. A short discussion of the disease conditions occurring in reptiles is found in each section.

Cardiovascular System

Introduction

Poikilotherms have been considered to have few primary cardiovascular disorders. Clinical cardiovascular disorders may be primary or secondary, and are associated with infection, parasitism, nutritional imbalances and poor husbandry practices. This section will present a limited review of reptile cardiovascular pathology.

Developmental Anomalies

Developmental anomalies are reported to be common in reptiles and are usually associated with deaths of juveniles. Incomplete development of the atroventricular valves has been described, leading to incomplete valve closure. A secundum atrial septal defect was described in a Komodo dragon (Varanus komodoensis). The lesion was on the craniodorsal portion of the septum. It led to chronic congestion of several organs. Two juvenile ball pythons (Python regius) with bifid ventricles were reported. All cardiac chambers were enlarged, the lesion disrupted the ability to separate pressures within the ventricles. An interventricular septal defect was also reported in an alligator (Alligator mississippiensis).

Non-Infectious Diseases

Aortic aneurysm rupture leading to cardiopulmonary arrest was described in a Burmese python (Python molurus bivittatus) and the exact cause was not determined. Arteriosclerosis has been documented in green iguanas (Iguana iguana) and dystrophic mineralization of arteries is seen in various lizards. Mineralization of arteries is most likely due to secondary nutritional hyperparathyroidism due to a calcium deficiency. A mole king snake (Lampropeltis calligaster...
rhombomaculata\textsuperscript{2} and a Deckert\textquotesingle s rat snake (Elaphe obsoleta deckertii)\textsuperscript{27} were diagnosed with cardiomyopathy of undetermined cause. The lesions in the king snake were primarily collagen proliferation and osteoid-like material, while the rat snake had degeneration and necrosis of myocardial fibers. Aortic stenosis with associated dilatation of the right atrium and the ventricle were found in an iguana.\textsuperscript{5} Histologically both aortic arches had narrow lumens with thickened intimas, and the myocardial fibers were attenuated. Although the cause was not determined the authors considered a chronic congenital lesion as one possibility.

Myocardial degeneration due to vitamin E deficiency has been seen in several reptile species.\textsuperscript{11} Grossly and microscopically the lesion is similar to that described in mammals. The heart will have mottled white to grey myocardium and histologically there will be multifocal to coalescing loss of myocytes replaced with dense fibrous stroma. Visceral gout can lead to severe pericardial lesions,\textsuperscript{19} as well as changes in the myocardium. These can include thickening of the pericardial sac with a deposition of the urate crystals as well as crystals forming within the myocardium. Primary disease can be nutritional or toxic.\textsuperscript{39}

**Infectious Diseases**

Infectious agents affecting the heart are usually secondary to systemic illness.\textsuperscript{40} Bacterial disease has been reported in conjunction with endocardial thrombosis,\textsuperscript{42} endocarditis,\textsuperscript{26} and myocarditis.\textsuperscript{17} *Chlamydophila* sp. infection is a cause of heart disease in reptiles. Granulomatous pericarditis and myocarditis was found in puff adders (*Bitis arietans*)\textsuperscript{22} and necrotizing myocarditis in green turtles (*Chelonia mydas*).\textsuperscript{15} Organisms could be demonstrated in macrophages in sections of paraffin-embedded heart. In emerald tree boas (*Corallus caninus*), there were histiocytic granulomas in the heart as well as in other organs. Small, basophilic organisms were seen on hematoxylin and eosin stained sections. Transmission electron microscopy of an intestinal granuloma demonstrated developmental stages of the chlamydial organisms.\textsuperscript{18}

Mycoplasma infection was seen in American alligators (*Alligator mississippiensis*).\textsuperscript{6} Rapidly growing mycoplasmas were identified by culture and polymerase chain reaction. The alligator isolate is a novel species in the mycoplasma family.

Spirorchid fluke (Digenea: Spirorchidae) infection was seen at necropsy of 96 stranded green turtles.\textsuperscript{13} Cardiovascular lesions included mural endocarditis, arteritis, and thrombosis, frequently accompanied by aneurysm formation. Spirorchid trematode eggs were noted in the heart and other organs in black turtles (*Chelonia mydas agassizii*).\textsuperscript{7} Seventy-five adult *Learedius learedi* were recovered from the heart of one of the turtles. During a 5-yr period, 16 freshwater turtles (*Trachemys scripta elegans* and *Chrysemys picta*) died spontaneously.\textsuperscript{29} Necropsy lesions included subcutaneous edema, hepatic necrosis, pancreatic necrosis, splenic necrosis, and intestinal parasites. Histologically, trematode eggs were seen within the myocardium, and in other tissues, associated with granulomatous lesions. The size and distribution of the eggs were consistent with Spirorchis sp. infection. Fluke infections can result in parasites within the three chambers of the heart and in major vessels (right aortic arch and brachiocephalic artery),
attached to the walls, or free in the lumen.\textsuperscript{12}

Whiptail lizards (*Cnemidophorus* spp.) from Texas and Colorado (USA), were examined for *Mesocestoides* sp. tetrathyridia and eleven (5\%) were infected. Free tetrathyridia were found in the body cavity of lizards and encapsulated tetrathyridia were observed in the heart, liver, and stomach.\textsuperscript{36}

West Nile virus infection led to myocardial degeneration and necrosis in a farmed American alligator.\textsuperscript{24}

\textbf{Neoplastic Diseases}

Primary tumors of the reptile cardiovascular system are not common. Among those reported are a rhabdomyosarcoma, in a boa constrictor (*Boa constrictor*), and a fibrosarcoma in a Gaboon viper (*Bitis gabonica*).\textsuperscript{35} Other tumors that may be primary or be part of a disseminated process include lymphoblastic malignant lymphoma in several species of reptiles.\textsuperscript{35} Thirty-nine percent of green turtles with fibropapillomatosis (FP) had disseminated internal tumors, most of them in the lung, kidney, and heart.\textsuperscript{58} Fibrosarcomas of low-grade malignancy were most frequently noted in the heart, and heart tumors had a predilection for the right atrium. A disseminated mast cell tumor diagnosed in an eastern kingsnake (*Lampropeltis getulus getulus*) involved the heart and numerous other organs.\textsuperscript{56} A disseminated chondrosarcoma involved the heart in a corn snake (*Elaphe guttata*).\textsuperscript{54} Large areas of myocardium had been replaced by neoplastic tissue. A metastatic oviductal adenocarcinoma has also been reported in the heart of a corn snake.\textsuperscript{47}

\textbf{Respiratory System}

\textbf{Developmental Anomalies}

References to congenital disorders of the lung of reptiles were not found.

\textbf{Non-Infectious Diseases}

It has been reported that the most common noninfectious cause of respiratory disease in chelonians results from trauma to the carapace.\textsuperscript{43} Though not well documented in the literature, pulmonary mineralization is occasionally seen secondary to osteodystrophy from any cause. In some cases this is limited to pulmonary blood vessels, but basement membranes may also be affected. Pleural urate deposition can be seen in cases of visceral gout.\textsuperscript{53} Inhalation of foreign material can lead to serious lung lesions and predispose to bacterial infections.\textsuperscript{41}

\textbf{Infectious Diseases}

Infectious diseases have been considered the most commonly reported pulmonary diseases in reptiles in several surveys.\textsuperscript{1,31,32} Several viral diseases are associated with pneumonia. Infection with West Nile virus (WNV) in addition to myocardial degeneration with necrosis produced a
mild interstitial pneumonia and lesions in many other organs in alligators.\textsuperscript{24} Immunohistochemistry identified WNV antigen in the tissues.

An adult male gopher tortoise (\textit{Gopherus polyphemus}) had signs of upper respiratory disease. On necropsy a severe, extensive necrotizing ulcerative tracheitis, multifocal necrotizing pneumonia, and multifocal necrotizing ulcerative pharyngitis and esophagitis were seen. Intracytoplasmic basophilic inclusions occurred within necrotic epithelial cells. On transmission electron microscopy virions and cytoplasmic inclusions were morphologically similar to those of the Family Iridoviridae.\textsuperscript{57} In other animals with Iridovirus (Russian tortoise [\textit{Testudo horsfieldii}], and a box turtle [\textit{Terrapene carolina}]) no lesions were described; however, a captive Burmese star tortoise (\textit{Geochelone platynota}), a wild gopher tortoise and five Eastern box turtles were found to be infected with Ranavirus. Several animals had varying degrees of multicentric vasculitis or thrombosis, necrosis of hematopoietic tissues, as well as multifocal necrotizing tracheitis. In some cases, basophilic intracytoplasmic inclusion bodies were observed within epithelial cells of the oral mucosa, esophagus, stomach, and trachea.\textsuperscript{30}

Herpesvirus caused intranuclear inclusion bodies and a large number of syncytial giant cells in the oral cavity and respiratory tract of a captive California desert tortoise (\textit{Gopherus agassizii}).\textsuperscript{48} Electron microscopically, herpesvirus particles were observed in intranuclear inclusions and in the cytoplasm. Viral stomatitis, tracheitis, and bronchopneumonia were complicated by a bacterial infection. Herpesvirus infection was also diagnosed in 14 juvenile (15 to 20-mo-old) green turtles with clinical signs of respiratory tract disease. Gross lesions included perilglottal necrosis, tracheitis with intraluminal caseous and laminated necrotic debris, and severe pneumonia. Microscopically, the turtles had fibrinonecrotic inflammation around the glottal opening, tracheitis, and severe bronchopneumonia and interstitial pneumonia. Multifocally, tracheal epithelial cells adjacent to areas of necrosis were karyomegalic and had amphophilic intranuclear inclusions. A secondary bacterial infection was noted. Ultrastructurally, intranuclear viral particles (88 to 99 nm in diameter) were seen. The particles most closely resembled those of herpesviruses.\textsuperscript{23}

A paramyxovirus related to parainfluenza 2 (PI2) virus was recovered from the lungs of two dead Ottoman vipers (\textit{Vipera xanthena xanthena}). Histologically there was interstitial pneumonia and degeneration and hyperplasia of bronchial and atrial epithelia. Scattered vacuoles, some of which contained eosinophilic inclusion bodies, were seen in the cytoplasm of several cells of affected epithelial tissues. Viral hemagglutination was inhibited by PI2 virus antiserum, but not by antisera to PI1, PI3, respiratory syncytial, or canine distemper viruses. Indirect immunofluorescence with PI2 viral antiserum specifically stained inclusions in the epithelial cells of respiratory tissues and infected cell cultures.\textsuperscript{50}

In one review\textsuperscript{1}, Gram’s stain negative bacterial infections were considered the most common cause of pneumonia in reptiles. Bacterial pneumonia can lead to systemic complications. In a group of sea kraits (\textit{Laticauda} spp.), nine died of sepsis secondary to necrotizing enteritis or pneumonia. Based on the clinical picture, it was considered that stress, such as transport, captivity, or possible concurrent viral infection, resulted in a septic event and death.\textsuperscript{4} Bacterial
Pneumonia was one of the most frequently encountered clinically significant lesions in Kemp's ridley sea turtles (Lepidochelys kempii).\textsuperscript{16}

In a group of California desert tortoises, 5 of 7 with respiratory disease had mycoplasmosis based on the presence of chronic proliferative rhinitis and positive serologic tests and/or isolation of Mycoplasma sp.\textsuperscript{14} Mycoplasma has also caused proliferative lymphocytic tracheitis and pneumonia in a Burmese python (Python molurus bivittatus). Polymerase chain reaction analysis of the 16S rRNA gene sequence indicated 0.90 similarity to Mycoplasma agassizii, an organism previously shown to cause respiratory disease in reptiles.\textsuperscript{46} Pneumonia has been seen as a part of systemic disease due to Chlamydophilia sp. infection in puff adders (Bitis arietans).\textsuperscript{22}

Mycobacterial infection can also cause pneumonia in reptiles.\textsuperscript{1,20,41} It is considered a sporadic disease in captive collections, usually seen as a chronic disease. A variety of mycobacterial genera have been isolated.\textsuperscript{20}

Mycotic pneumonia has been considered an occasional but uncommon diagnosis in reptiles,\textsuperscript{41} with a variety of organisms isolated. Suboptimal temperatures\textsuperscript{43} can lead to mycotic pneumonia in captive chelonians. Other reported causes include mycotic pneumonia associated with Aspergillus sp. in green anacondas (Eunectes murinus),\textsuperscript{37} and chronic pneumonia in a desert tortoise with respiratory disease.\textsuperscript{14} In snakes, most cases of systemic mycosis begin in the lungs and then disseminate.\textsuperscript{21}

Several types of reptile parasites have at least a portion of their life-cycle in the lung.\textsuperscript{41} Nematodes of the genus Rhabdia lay eggs within the pulmonary parenchyma. If the eggs rupture, there can be a marked inflammatory response.

Lungworm infection was seen in loggerhead sea turtles (Caretta caretta). The lungworms may not have been the primary cause of illness, and they may be only contributory or incidental. Lesions in those that died included tracheal and bronchial epithelial hyperplasia and goblet cell hyperplasia. Lesions caused directly by the parasites seem to be restricted to the upper respiratory tract; debris produced by the worms may lead to changes in the lungs.\textsuperscript{34}

Two Bosc's monitor lizards (Varanus exanthematicus) developed clinical signs of pentastomiasis. One died of chronic parasitic pneumonia associated with adult pentastomids of an undescribed Sambonia sp. Eggs and immature pentastomids were also seen in histologic sections of the lungs and liver. The other animal had fragments of pentastomid larvae in a laryngeal biopsy, and the animal recovered after treatment with ivermectin and supportive therapy.\textsuperscript{10} Several genera of trematodes can cause lesions in the lower respiratory tract of reptiles.\textsuperscript{41} Identification of eggs from lung or tracheal washes is necessary for an exact etiologic diagnosis.

Protozoal infections of the lung can occur in reptiles. At necropsy of a bearded dragon (Pogona vitticeps) with nonspecific signs of illness, severe hepatic necrosis was associated with clusters of light basophilic intracytoplasmic microorganisms within and distending hepatocytes and free
in areas of necrosis. Similar microorganisms were within cytoplasmic vacuoles in renal, pulmonary and gastric epithelial cells, enterocytes, capillary endothelial cells, and ventricular ependymal cells in the brain. The microorganism was Gram’s stain positive, acid fast stain positive, and had a small polar granule that stained using the periodic acid-Schiff reaction. Electron microscopy revealed merogonic and sporogonic stages of a protozoa compatible with members of the phylum Microspora. An intranuclear coccidia has been seen in the lung of several species of captive tortoises in the United States, leading to severe proliferative pneumonia in some cases.

**Neoplastic Diseases**

In one survey two primary adenocarcinomas of the respiratory tract were listed, one of tracheal origin and the other a bronchogenic carcinoma. Tracheal chondromas seem to have a predilection for ball pythons (*Python regius*). A 9-yr-old female was evaluated and on histologic examination, the mass was determined to be an intratracheal chondroma. Clinical signs of recurrence of respiratory compromise had not been observed 9 mo after surgery. Over a 9-mo period, three adult ball pythons were evaluated for severe dyspnea. Partial obstructions of the tracheal lumen were identified radiographically and/or visualized. Histologically, lesions from two of the snakes were tracheal ring chondromas and appeared to be benign.

Disseminated tumors such as lymphoma can involve the lung and a variety of metastatic tumors have been reported. These include fibromas, oviductal carcinoma, chondrosarcoma, squamous cell carcinoma, fibrosarcoma, and a plasma cell tumor.

**LITERATURE CITED**


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