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MYOPATHIES OF DOGS AND CATS
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In small animals, myopathies are relatively uncommon and encountered less frequently than neuropathies and junctionopathies, while the converse generally is true in large animals. Myopathies may be subdivided into non-inflammatory and inflammatory myopathies (Table 1).

Table 1: Classification of Myopathies.

1. Non-Inflammatory Myopathies
   a. X-linked Muscular Dystrophy
   b. Metabolic Muscle Disorders
      i) Malignant Hyperthermia
      ii) Myotonia
      iii) Glycogen Storage Disorders
      iv) Lipid Storage Myopathies
      v) Electrolyte Myopathies
      vi) Mitochondrial Disorders
2. Inflammatory Myopathies
   a. Masticatory Muscle Myositis
   b. Polymyositis
   c. Dermatomyositis
   d. Protozoal Myositis
3. Idiopathic Myopathies
   a. Fibrotic Myopathy
   b. Infraspinatous Contracture
   c. Myositis Ossificans
4. Neoplastic Myopathies

Non-Inflammatory Myopathies

The histopathological changes in non-inflammatory myopathies usually involve the spectrum of myonecrosis, phagocytosis, and regeneration, *in which the degree of cellular infiltration is proportional to the extent of myonecrosis present*, and its distribution is largely limited to necrotic fibers. *Macrophages* constitute the principal cell type. *Central nuclei* are common. In chronic myopathies there may be a mixture of atrophied and hypertrophied fibers, with their morphology being more "anguloid" than angular, and increased endomysial connective tissue. Occasionally necrotic fibers may be calcified. All these changes are relatively non-specific and secondary to agents that result in myonecrosis. In metabolic myopathies the fibers frequently contain storage products that appear as vacuoles.
a. X-Linked Muscular Dystrophy of Dogs and Cats

This is an hereditary myopathy in which there is a deficiency of dystrophin, a cytoskeletal protein associated with the inner surface of the sarcolemma. The disorder is best characterized in Golden Retrievers. Other breeds of dog affected include Rottweilers, Samoyeds, and possibly Irish Terriers. In cats it has been documented in domestic short hair cats. In dogs the disorder usually is recognized between 8 and 10 weeks of age. Signs may include generalized weakness, a stiff-limbed, short strided, shuffling gait, some reduced mobility of the jaws, and difficulty with chewing and swallowing associated with excess salivation. The weakness and signs are progressive, with poorly developed muscle mass, body stature, and spinal curvature. In advanced stages some muscle groups may appear grossly hypertrophied. Cardiac muscle may also become involved.

Recognition of this disorder in cats is more recent and the findings are similar to those in dogs. While the onset is likely similar to that in the dog, reported cases have been somewhat later in onset, 5 to 25 months of age. Gross hypertrophy of the tongue and diaphragm have been a common finding in cats. Currently there is no cure and lifespan is shortened due to secondary complications. Future research advances in this area will have widespread benefits for both animals and humans.

b. Metabolic Muscle Disorders

These are relatively uncommon disorders of carbohydrate, lipid, and oxygen metabolism that generally induce muscle weakness by supplying insufficient energy (ATP) to sustain muscle contraction, and other cellular functions with a high energy requirement (e.g., maintenance of active transport and ion gradients across the cell membrane).

i) Malignant Hyperthermia

Malignant hyperthermia (MH) is a life-threatening hypermetabolic and contractile condition that is triggered in humans, pigs, dogs and cats by certain anesthetic agents (e.g., halothane and succinylcholine). The underlying defect in calcium (Ca) homeostasis occurs at the level of the skeletal muscle sarcoplasmic reticulum where there is hypersensitive and heightened ligand-gating of the Ca-release channel. Malignant hyperthermia has been reported in various breeds of immature and mature dogs: St. Bernard, Border Collie, Labrador Retriever, Pointer, Spaniel, Greyhound and animals crossbred with Doberman Pinscher. MH has been reported only sporadically in cats.

ii) Myotonia

Myotonia is a disorder in which there is sustained (tetanic) muscle contraction associated with repetitive depolarization of muscle fibers. In affected individuals, the is involuntary contraction of a muscle that persists after voluntary movement or stimulation. Congenital myotonias occur in goats, dogs, (Chow Chow, Cocker spaniel, miniature Schnauzer, Labrador retriever, Samoyed, Staffordshire terrier, West Highland white terrier), horses, cats and humans. The main defect is an altered chloride conductance, associated with a genetic defect in the chloride channels of the t-tubules.
iii) Glycogen Storage Disorders

- Type II: amylo-1,4-glucosidase (acid maltase) deficiency, Swedish Lapland dog. A lysosomal storage disorder. Excess glycogen accumulation in skeletal and cardiac muscle as well as CNS.
- Type IV: α-1,4-glucan transferase and α-1,6-glucosidase (debranching enzyme) deficiency has been reported in dogs and cats with diffuse organ involvement.
- Type VII: Phosphofructokinase deficiency reported in Springer spaniel dogs. Hemolytic episodes are predominant signs.

iv) Lipid Storage Myopathies
Sporadic cases have been reported in dogs with lipid storage in type 1 fibers

v) Electrolyte Myopathies
Abnormalities of potassium metabolism involving both hypo- and hyperkalemic states, frequently result in accumulation of fluid filled vacuoles. Hypokalemic myopathy is a metabolic disorder of older cats that has been linked with chronic renal disease and excessive urinary potassium loss. Synonyms are feline kaliopenic polymyopathy-nephropathy syndrome, and sporadic feline hypokalemic polymyopathy

vi) Mitochondrial Disorders
Mitochondrial disorders appear to be rare

Inflammatory Myopathies

The inflammatory myopathies possess many of the changes described for non-inflammatory myopathies. However, in addition, they are characterized by a disproportionate number of infiltrating cells that may include lymphocytes/plasma cells, polymorphonuclear leukocytes and/or eosinophils in addition to macrophages. In these disorders, the cellular infiltrates comprise an integral part of the disorder’s pathogenesis and not merely a secondary response to cell death. The infiltrating cells often have a perivascular distribution.

Identification and characterization of the infiltrating cell type assists in the definition and recognition of these disorders. The use of the term "myositis" is reserved for inflammatory myopathies. Inflammatory myopathies may be caused by infectious or immune-mediated disorders.

a. Masticatory Muscle Myositis
An inflammatory muscle disorder limited to the muscles of mastication in dogs. Muscles of mastication in dogs are composed predominantly of 2M fibers, which differ from the 2A fibers in limb muscles. Type 2M fibers are selectively affected in this disorder

b. Polymyositis
Polymyositis is a relatively common myopathic disorder in dogs, but less common in cats. It has been suggested that polymyositis, masticatory myositis and other clinical variations, such as pharyngeal-esophageal and focal appendicular myositis, may represent different clinical and pathological
expressions of a single primary muscle inflammatory disease. The cause of polymyositis in dogs is not always known, although the responsiveness of the disease to immunosuppressive therapy suggests that the pathogenesis is immune-mediated.

i. Feline Idiopathic Polymyositis
ii. Extraocular Myositis
iii. Dermatomyositis
iv. Protozoal Polymyositis

Idiopathic Myopathies

i. Fibrotic Myopathy
ii. Infraspinatous Muscle Contracture
iii. Myositis Ossificans

Neoplasia

Muscle tumors may be primary, originating from skeletal muscle (rhabdomyoma, rhabdomyosarcoma), or secondary (metastatic spread from tumors originating elsewhere, or local invasion of tumors into muscle from rapidly expanding cutaneous or bone tumors.

References
