Skeletal muscle changes associated with equine myotonic dystrophy*

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Summary. A progressive neuromuscular disorder in young horses, clinically apparent as early as 1 month of age, is characterized by generalized myotonia, muscle stiffness, muscle weakness and atrophy. Myotonia is identified by percussion dimpling and myotonic EMG discharges. Changes in one case included testicular hypoplasia, cataract formation, and glucose intolerance, indicating a systemic involvement. Pathologic changes in skeletal muscles from three affected foals were examined. Sarcoplasmic masses, ringed fibers, internal positioning of sarcolemmal nuclei, and nuclear rowing were among the primary histologic changes noted. Variation in fiber diameter size, especially atrophy, and type I predominance were also prominent changes. A neurogenic involvement was indicated by type grouping changes in several muscles.

Key words: Muscular dystrophy - Myotonic dystrophy - Animals

Myotonia, a sustained contraction of muscle after stimulation, is expressed clinically by percussion dimpling and electrophysiologically by myotonic discharges of repetitive high frequency which increase and decrease in amplitude [18]. Members of a group of familial human neuromuscular diseases which are accompanied by myotonia as a major clinical component include myotonic dystrophy, myotonia congenita, paramyotonia congenita, and hyperkalemic periodic paralysis [1, 14]. Although all of these disorders are accompanied by myotonic discharges of varying frequency and severity, each is a distinct entity differentiated by clinical, electrophysiologic and pathologic characteristics [8, 15, 24, 27, 30].

Myotonic dystrophy (MyD) is the most severe and frequently identified member of the group of neuromuscular disorders attended by myotonia [24, 30]. In MyD, the clinical manifestations of the skeletal muscle dysfunction progress from skeletal muscle weakness to muscle atrophy and locomotor dysfunction [15, 27, 30]. The disease is a multisystem disorder which not only affects components of the neuromuscular system [1–3, 6, 8, 14, 15, 19, 20, 22–24, 27, 30], but also the ocular, immunologic, gastrointestinal and endocrine systems, especially the pancreas and gonads [15, 24, 30]. The disorder is clinically manifested between the second to fourth decades of life; however, a congenital form is recognized at birth or in the early postnatal period [28].

We have identified a severe and progressive neuromuscular disorder in young horses which resembles myotonic dystrophy [16]. This progressive disorder is clinically apparent as early as 1 month of age, and is initially characterized by generalized myotonia with hypertrophy and hypertonicity of the larger proximal muscles of the rear and fore limbs. As the disease progresses, muscle stiffness, weakness, and atrophy develop. Prolonged percussion dimpling can be elicited, especially in the large proximal rear-limb muscles. Myotonic discharges are identified electromyographically in the large proximal muscles of the fore and rear limbs. Clinical findings in one case indicate a multisystem disorder with testicular hypoplasia, early cataract formation and mild glucose intolerance. This report concerns the histologic and histochemical description of the skeletal muscle changes of this form of myotonia in three foals.

Materials and methods

Three foals (two males and one female) were examined for pathologic changes after a diagnosis of myotonia was made. Clinical findings included progressive muscle disorder accompanied by percussion myotonia and muscle hypertrophy, weakness, atrophy, and stiffness. The electrophysiologic changes in the skeletal muscle were characteristic of myotonic disorders with the typical myotonia...
electromyographic changes of audible “divebomber” sounds and crescendo-decrescendo muscle action potentials.

The owners reported that this condition had not previously occurred on their ranches and pedigree examinations of the three foals revealed that they were apparently not closely related. The foals had no known exposure to agents known to produce acquired myotonia.

Case 1

This was a male, quarterhorse foal first examined at the age of 1 month when the owner complained of a gait disorder. The foal had a hopping, stiff gait which primarily involved the hind limbs. The larger proximal muscles of the rear limb, especially the gluteal muscles, appeared prominent. The neuromuscular involvement progressed over a course of 9 months, and finally the colt was unable to rise without assistance. The foal had slightly elevated creatine kinase levels (249 IU/l) and low serum testosterone levels (0.04 mg/ml) compared to other foals of his age. The colt had borderline glucose intolerance, testicular hypoplasia, and mild lenticular opacities of the lens.

Case 2

This was an 8-month-old, castrated male admitted because of a stiff gait. Proximal muscles of the fore and rear limbs were prominent. Percussion myotonia was observed in the large proximal muscles of the rear limbs and myotonia was confirmed electromyographically. The foal’s neuromuscular condition deteriorated over a 2-month period. Clinical laboratory tests, including creatine kinase levels and serum electrolyte levels, were within normal range.

Case 3

This was a 2-month-old female foal referred for examination because of muscle stiffness. The proximal muscles of the rear limb appeared enlarged and this prominence was especially noticeable in the semimembranous and semitendinosus muscles. A form of myotonia was identified based on percussion myotonia and the electrophysiologic changes of myotonic discharges of the large proximal muscles of the fore and rear limbs. Creatine kinase levels were significantly elevated (5094 IU/l). Aspartate aminotransferase (AST) (260 IU/l) and cholesterol levels (481 mg/100 ml) were also elevated. Other clinical laboratory tests, including creatine kinase levels and serum electrolyte levels, were within normal range.

Histologic examination

The major changes noted were ringed fibers, sarcoplasmic masses, alteration in the shape and position of nuclei, nuclear rowing, variation in fiber diameter size, and an increase in endomysial and perimysial connective tissue.

Ringed fibers or fiber annuli were most pronounced in the semimembranous and semitendinosus muscles stained with PTAH (Fig. 1). The rings were characterized by narrow rim of striated myofibrils on the periphery of the fiber or just beneath a portion of partial or completely circumvented myofibril-poor sarcoplasm (sarcoplasmic mass) in transverse-sectioned fibers.

Sarcoplasmic masses were observed in both the peripheral and central regions of the muscle fiber (Figs. 1, 2). The peripherally located sarcoplasmic masses consisted of lighter staining sarcoplasm devoid of myofibrils. The masses were often in a crescent shape which was associated with a slight outpouching of the sarcolemmal membrane. Less often, they completely encircled the periphery of the muscle fiber as a band of sarcoplasm which stained more homogeneous and lighter with eosin than the adjacent internal myofibril-containing sarcoplasm. The sarcoplasmic masses were also observed in the central portions of the muscle fiber, appearing as a lake of homogeneously eosinophilic staining sarcoplasm devoid of myofibrils. The sarcoplasmic masses stained moderately intensively with the PAS and NADH diaphorase stains and were devoid of ATPase activity. Nuclei were present in some sarcoplasmic mass regions; often these nuclei appeared to have a plump vesicular appearance as opposed to the more hyperchromatic nuclei in the other regions of the cell.