

## Muscular Dystrophy of the Diaphragmatic Muscles in Holstein-Friesian Cows

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(Received 4 February 1994/Accepted 17 May 1994)

**ABSTRACT.** Six Holstein-Friesian cows suffering from recurrent rumenal tympany were pathologically investigated. Macroscopical lesions associated with the clinical symptoms were confined to the diaphragmatic muscles which were pale, and stiff on palpation. Histopathological examination revealed various degenerative changes in diaphragmatic muscles as follows: variation in muscle fiber diameter, vacuolar and hyalinized degeneration of muscle fibers, fiber splitting, central core-like structures, sarcoplasmic masses and ring fibers. These characteristic features in the present cases were consistent with dystrophy of the diaphragmatic muscles in Meuse-Rhine-Yssel cattle. From these observations, it is confirmed that muscular dystrophy of the diaphragmatic muscles does occur in Holstein-Friesian cows, although a genetic mode was not proven.—**KEY WORDS:** diaphragmatic muscle, Holstein-Friesian cattle, muscular dystrophy.

*J. Vet. Med. Sci.* 56(5): 993–994, 1994

In general, the term muscular dystrophy refers to primary skeletal muscle disease which is genetically transmitted and characterized by progressive, degenerative changes and gradual loss of muscle fibers. Muscular dystrophy in man is well described and classified according to the form of inheritance and the pattern of selective muscle involvement [6]. In domestic animals, muscular dystrophy is known to occur in cattle, horses, sheep, pigs, dogs and cats [1]. In cattle, dystrophy in the diaphragmatic muscles has been reported in Meuse-Rhine-Yssel cattle in the eastern part of the Netherlands [3, 4]. To our knowledge, there are no descriptions of dystrophies in other breeds of cattle in the literature apart from the case of Meuse-Rhine-Yssel cattle. Recently, muscular dystrophy was found in the diaphragmatic muscles of Holstein-Friesian cattle suffering from recurrent rumenal tympany. This note describes the histopathological features with particular emphasis on the existence of this disease in Holstein-Friesian cows.

Animals used for this investigation were six cows, 4 to 7 years old. Two cows (case Nos. 1 and 2) were autopsied after euthanasia, and the others (case Nos. 3–6) were slaughtered. Tissue blocks were collected from the whole body including skeletal muscles of case Nos. 1 and 2, and the diaphragmatic muscles of case Nos. 3–6, respectively.

For histopathological examination, tissue samples were fixed in 10% phosphate buffered formalin and embedded in paraffin. Sections were stained with hematoxylin and eosin (HE). Selected sections from the skeletal muscles were stained with Azan and phosphotungstic acid-hematoxylin (PTAH).

Clinically, all cases showed reduced eructation and recurrent rumenal tympany. In case Nos. 1 and 2, the treatment proved futile and the course steadily progressive.

Macroscopically, the diaphragmatic muscles of all cases were slightly swollen, pale, and stiff on palpation. No

abnormality was noticed in the other muscles of case Nos. 1 and 2.

Microscopical lesions were observed in the diaphragmatic muscles, skeletal muscles, especially both internal and external intercostal muscles, and cardiac muscles. However, it is intended in this paper to describe the histopathological changes of the diaphragmatic muscles. A more detailed account including the other muscles and cardiac muscles will be given in another paper. The most characteristic features of the diaphragmatic muscles were great variation in muscle fiber diameter, vacuolar degeneration of muscle fibers and internal disposition of nuclei (Fig. 1). Also seen were necrotic fibers which were often engulfed by phagocytes. Another prominent feature was the presence of central core-like structures in fibers which contained a zone of a dense, amorphous, relatively hyalinized substance (Fig. 2). Moreover, a number of disoriented fibers which retained a peripheral zone of sarcoplasm devoid of myofibers referred to as sarcoplasmic masses were also noted (Fig. 2). The nuclei associated with these changes were vesicular, swollen, round, and poor in nucleoplasm. These lesions were distributed diffusely through the entire muscle of all affected cows, although there were differences in degree of severity among affected cows. Ring fibers which were arranged circumferentially by the disoriented myofibers were rarely found (Fig. 2). In addition to these degenerative alterations, regenerating and reacting changes represented by nuclear chain, splitting of muscle fibers associated with hypertrophic fibers, and slight endomysial fibrosis were occasionally seen.

In the present cases, various degenerative changes including variation in muscle fiber diameter, central core-like structures, sarcoplasmic masses, and ring fibers through the diaphragmatic muscles of all affected cows were common features, and are indicative of primary degenerative disorders of muscles [2]. However, our cases differ from the nutritional myopathies characterized by phagocytosis of necrotic fibers and abundant regeneration [5]. The diaphragmatic myopathy (or dystrophy of the

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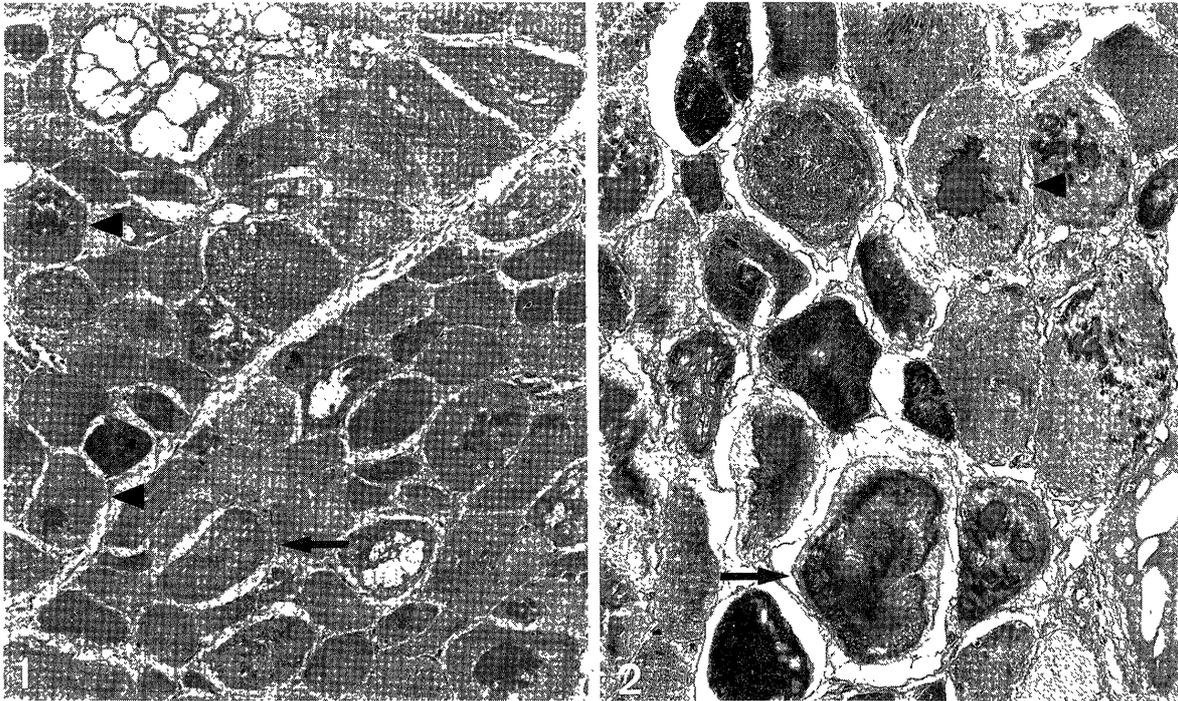


Fig. 1. Various degenerative changes in the affected diaphragmatic muscle. Great variation in fiber diameter and vacuolar degeneration are prominent. Sarcoplasmic mass (arrow) and central core-like structures (arrow heads) are also observed. HE.  $\times 130$ .

Fig. 2. Characteristic features in the affected diaphragmatic muscle. Central areas in sarcoplasmic mass (arrow) and central core-like structure (arrow head) are stained darkly. Ring fiber which has a peripheral striated ring is seen. PTAH.  $\times 240$ .

diaphragmatic muscles) in Meuse-Rhine-Yssel cattle is well known as a unique disease which mainly affects the diaphragmatic muscles [3]. The main clinical symptom in this disease are anorexia, reduced rumination and eructation; and recurrent rumenal tympany. Histologically, the diaphragmatic muscles are affected severely and diffusely, as characterized by variation in size of individual fibers, abundant vacuolar and hyaline degeneration with occasional fragmentation and phagocytosis, fiber splitting, apparent increase in internal nuclei and vesicular nuclei. Central core-like structures are thought to be one of the hallmarks of this disease [3]. The pathological alterations and clinical symptoms in the present cases are consistent with the diaphragmatic myopathy in Meuse-Rhine-Yssel cattle. As implied by these findings, this unique myopathy is present in Holstein-Friesian cows. Genetic factors are strongly suggested to be involved in the diaphragmatic myopathy in Meuse-Rhine-Yssel cattle, although a proven genetic basis is lacking [3]. The pedigrees in the present

cases are incomplete although a certain bull is suspected to be the carrier at present. A genetic mode may be involved in the transmission of this myopathy.

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