RESPONSE OF EQUINE MUSCLE TO EXERCISE
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Key Points:
- Equine muscle is highly responsive to exercise, which stimulates well-characterized changes in fiber type composition and the metabolic functions of muscle tissue.

Muscle Fiber Type Distribution: The muscular system represents one of the most crucial systems of the equine athlete, and it is therefore not surprising that breed differences in this system exist, particularly in characteristics such as muscle fiber type. Muscle fiber type (slow or fast twitch) is determined by the isoform of the myosin heavy chain that the fiber contains. The different myosin isoforms determine the activity of the myosin ATP’ase enzyme, which controls the velocity of muscular contraction. However neural input is probably the ultimate determining factor of a muscle fiber’s myosin isoform (and therefore muscle fiber type).

There are two commonly accepted fiber type classification systems. The first divides fibers into type I, type IIA and type IIX (formerly IIB) categories. Hybrid fibers (IIAX) have also been documented to exist. These groups largely correspond to the slow twitch (ST); fast twitch glycolytic, high oxidative capacity (FTH); and fast twitch glycolytic, low oxidative capacity (FT) categories of the second classification system.

In general, slow twitch fibers (type I) contain a myosin isoform with low ATP’ase activity, and are therefore slow to contract, slow to relax and very fatigue resistant. These fibers comprise the major fiber type in postural muscles, and are highly aerobic with abundant mitochondria and lipid stores. These fibers also have a high myoglobin content, high capillary density and smaller cross sectional area to support oxygen uptake and utilization. In contrast, fast twitch fibers (type IIA, IIX, FTH and FT) contain more glycogen and creatine phosphate and other enzymes involved in glycogenolysis and glycolysis. These fibers have high myosin ATP’ase activity and a more developed sarcoplasmic reticulum to allow faster muscle contraction and relaxation, and greater maximal tension development. They are also more susceptible to fatigue.

Fiber type composition of muscle tissue varies significantly not only between breeds, but also between muscles, and even within a particular muscle. However, composition usually reflects the required activity. For example, horses bred to race at speed, such as Quarter horses and Thoroughbreds, have a higher proportion of fast twitch fibers (80-90%) compared to horses such as Arabians that have been selected for endurance events (75% or less fast twitch fibers). Additionally, the propulsive locomotor muscles such as the gluteal muscles contain the largest percentage of fast twitch fibers. However, the greatest proportion of type II fibers is found superficially in the muscle, with slow twitch fibers concentrated deep in the muscle tissue where there is almost an absence of type IIX fibers. This likely reflects the orderly pattern of fiber recruitment with muscle activity, with deep muscle tissue used for postural purposes and recruited first for activity, and the more superficial tissue being recruited when progressively greater physical efforts occur. However, because of these variations in muscle fiber distribution it is critical to utilize a standardized site for muscle biopsy. Other measurable variables such as muscle glycogen and lactate concentrations are also influenced by sampling depth and fiber type.
**Fiber recruitment during exercise:** During exercise, there is an orderly progression of muscle fiber recruitment within the active muscles, depending on the activity occurring. Fiber recruitment patterns are therefore dependent on the speed, intensity and duration of the exercise task, and the gait which the animal is moving in.

Type I fibers are innervated by the smallest alpha-motor neurons, which have the lowest threshold and are more easily depolarized. Therefore, during slow, low intensity exercise, type I fibers are the major fiber type recruited, along with some type IIA fibers. As the speed or duration of the exercise task increases, orderly recruitment occurs in order of fiber contractile speed. Thus hybrid IIAx fibers will be recruited after IIA fibers. Type IIX fibers are innervated by the largest motor neurons and only recruited near maximal intensity (high speeds, jumping) or after several hours of submaximal exercise when many fibers are beginning to fatigue.

Although attempts have been made to correlate muscle fiber type with performance in horses, since fiber type composition is influenced by many factors, including age and training, it is difficult to justify muscle fiber typing as a useful determinant of a horse’s performance potential. However there is no doubt that genetics play a very important role in determining fiber type composition which ultimately results in breed suitability to specific tasks. Muscle fiber traits that appear to be strongly heritable include fiber type percentages, total fiber number and the relative size of type I and II fibers.

**Skeletal Muscle Adaptations with Training:** Skeletal muscle displays rapid and dramatic changes in metabolic characteristics with training. Even low intensity submaximal exercise programs can produce a significant increase in muscle oxidative capacity. Important changes stimulated by training include increased aerobic enzyme activity, an increased IIA to IIX ratio with a concurrent increase in the number of IIX fibers with high versus low oxidative capacity, and a concurrent increase in mitochondrial volume, myoglobin content, and capillarization of muscle fibers to support oxidative activity. Additional changes that are observed include an increase in intramuscular glycogen content, and an increase in muscle carnitine content which likely facilitates the transport of fatty acids into the mitochondria for oxidation.

The major result of skeletal muscle adaptation to training is increased oxidative capacity which allows more efficient utilization of energy substrates. For a given workload, oxygen consumption will be similar between a trained and untrained animal, however, in the trained animal there will be slower utilization of muscle glycogen and blood glucose, greater reliance on fat oxidation, and less lactate production at a given intensity. It should be kept in mind however that training tends to provoke changes only in those muscle fibers that actually get recruited. Therefore intervals of fast work are required to affect IIX fibers, which may not be recruited until 70-80% of race speed is achieved in a training session.