

Galloping and breathing at high speed

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The coordination of two systems are key for any horse to walk, trot, gallop or win a race. The first are the lower limbs, which allow the animal to move along on a "spring-like" tendon. The second is a complicated respiratory system, which allows a horse to take in one breadth for every stride they make while racing. For more than a decade a team of researchers has been working to unlock the secrets of equines. Their findings may provide a springboard for better muscular horse health, and a different approach to breathing devices for humans.

John Hermanson, Norm Ducharme and Jonathan Cheetham, all of the Cornell University College of Veterinary Medicine, Ithaca, NY, John Bertram, University of Calgary, College of Medicine, Calgary, Alberta, CN, and Michael Butcher, Department of Biological Sciences, Youngstown State University, Youngstown, OH, comprise the research team. Dr. Hermanson will discuss the group's work at the American Physiological Society's (APS) (www.The-APS.org) meeting, The Integrative Biology of Exercise V. The conference is being held September 24-27, 2008 in Hilton Head, SC.

Equine Movement

The lower limbs (legs) of horses are what allow them to move, either by walking, trotting, galloping or jumping. An elastic storage area is located inside the forelimbs, made up of long tendons. These tendons are vulnerable to injury during high speed training or racing.

The researchers focused their efforts on understanding why this occurs.

They found that two principal muscular factors in the fore limb guide a horse's forward movement. The first is the springy "pogo-stick" quality of the superficial digital flexor tendon, which provides the "bouncing" effect, which allows for trotting and, to a lesser extent, galloping. The second is work generated by the parallel deep digital flexor, which moves the horse forward over the ground. It is the balance between these two muscles that is required for horses to be able to move.

Out of these discoveries have come the potential for veterinary applications. Among them is the possibility that some of the breakdown in the forelimbs may be related to fatigue within the deep digital flexor resulting from stress and strain on the tendons of the animal.

According to Dr. Hermanson, "Fatigue of the deep flexor muscle may overload the superficial digital flexor muscle and tendon, especially towards the end of intense, high-speed exercise.

The Importance of Respiration

When a horse is running, its breathing and stride are linked in a 1:1 ratio, so for every stride they take, they also take one breath. The peak airflow they generate is very high (about 80 liters per second). Thus, a very small defect in the airway can cause a big decrease in performance. Two cartilages (the arytenoids cartilages) protect the larynx during swallowing. When the horse swallows, these cartilages close; when the horse breathes, the cartridges open. When the horse exercises, they open to the maximum extent possible in order to as much airflow as possible to reach the lungs.

These cartilages are opened by a muscle that is innervated by a long nerve, the recurrent laryngeal nerve, which runs from the brain, down the neck, and around the base of the aorta. This nerve is susceptible to

disease and damage. When that occurs, the muscle does not function properly, so it is unable to properly open the cartilage. As a result, the cartilages collapse, obstruct the airflow and lead to a poor performance from the horse.

An Airway Solution for Horses ... and People?

For the last three years the researchers have been developing a pacemaker for the larynx. The electrical implant can be placed into the muscle or around the nerve in order to stimulate the muscle and keep it open during exercise. The implant has been developed to the point where it can be used to keep the airways of horses running 35-40 miles per hour, fully open.

The researchers are part of a team looking at application for the pacemaker for humans for individuals who have laryngeal paralysis or undergo laryngeal transplant. The disorder can be a complication of thyroid surgery in people who have had thyroidectomies, usually to remove cancer from the thyroid gland. In addition to the paralysis, it can effect speech, voice and swallowing. According to Dr. Cheetham, "We are hopeful that this pacemaker, tried in horses, will eventually be helpful to humans."

According to Dr. Hermanson, "Horses are uniquely designed athletes that are exceptionally useful for the study of limbs, respiration and other systems of the body. This type of translational research benefits all concerned."

Source: American Physiological Society

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