

## **SOUTHERN CALIFORNIA EQUINE FOUNDATION, INC.**

### **Improving Diagnosis of Joint Disease In Horses**

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Clinical examination (lameness examination) and radiographs are the most common techniques used by veterinarians to diagnose joint disease in horses. However, both forms of diagnosis are subjective, and radiographs only give a two-dimensional image of a three-dimensional structure. This often leads to an inability to detect early, subtle lesions which often worsen with continued training. Furthermore, it is difficult, if not impossible to identify horses that may end up with a joint problem in the future.

Two things must occur in order to predict joint disease in a particular horse, or at least to be able to diagnose very subtle lesions. The first is that the joint of interest must be viewed in 3 dimensions. The second is that the forces (the amount of weight the joint must withstand) should be known. Technology exists in human orthopedic fields to do both, and efforts are now underway to use this technology in horses.

The stresses that equine joints must withstand are unknown. Methods to determine these have been developed in humans and are now being developed for horses by investigators in the Equine Orthopaedic Research Laboratory at Colorado State University. In human medicine, Magnetic Resonance Imaging (MRI) is used for diagnosis of subtle joint diseases. This imaging modality gives a three-dimensional representation of the joint structure. Advances in MRI have led to the ability to view damage in joints and to also calculate the amount of force on the tissues of the joint. Such technology has great potential for diagnosis of equine joint disease. However, studies of these techniques for horses need to be performed. The purpose of this article is to discuss new techniques that can be used to characterize joint function and improve early diagnosis of joint disease.

### Joint Disease

Similar to heart disease, joint disease involves an entire organ. Doctors, veterinarians and researchers have concentrated on the study of articular cartilage in the hopes of better understanding joint disease. The loss of articular cartilage can lead to irreversible osteoarthritis. However, the steps that lead to articular cartilage loss often involve a problem with the whole joint. The joint is made up of several tissues in which injury can occur, including both hard and soft tissues. Soft tissues include synovial membrane, joint capsule and ligaments. Hard tissues include articular cartilage and subchondral bone. Radiographs can only characterize the bone tissue, which leaves equine veterinarians with the inability to accurately diagnose soft tissue and articular cartilage damage. Once injury occurs to any of these tissues, then a vicious inflammation cycle is established in which other tissues are secondarily affected.

A study funded by the Dolly Green Research Fund, administered by the Southern California Equine Foundation, in collaboration between the Equine Orthopaedic Research Laboratory at Colorado State University, the Steadman-Hawkins Sports Medicine Foundation in Vail, Colorado and the Orthopaedic Research Laboratory at Columbia University in New York City is underway to develop a model of the equine carpus (knee) and compare the results to MRI in the hopes of using this method for early diagnosis of joint disease in horses.

In the first part of the project, six horses were trained to a high-speed treadmill at a gallop. Joint angles and muscle forces were analyzed with a 3-dimensional motion analysis system. Six markers were placed above and below the carpus of each horse, and 5 high-speed cameras were used to follow the markers through space as the horses ran on the treadmill. At the same time, EMG electrodes (which are responsible for detecting muscle forces) were placed over 8 muscles in the forearm. These 8 muscles, in addition to the horse's body weight, are responsible for the forces in the carpus. Data from the horses were recorded at a trot and a gallop over 20 second periods and data were analyzed.

In the second part of the study, data acquired from part one of the study were used on cadaver limbs to develop a model of joint stresses. Briefly, each carpus was placed within a loading machine that was specially designed for human cadaver knees. (Figure 1) Muscle forces, as calculated from part one of the study, were applied to the carpus, and direct force (simulating body weight) was applied to the limb as the carpus was placed through various angles. A special tracking device was used to follow all of the carpal bones through space as forces were applied.

This allowed for the investigators to build a 3-dimensional computer model of the equine carpus. (Figure 2) The bones were then removed from the joints, and photographed using a special 3-dimensional technique that can be used to calculate the contour of the bone surfaces in the joint. These data were also put into the computer model, and a final model of the joint was constructed. This model included measurements of joint surface forces and articular cartilage thickness. (Figure 3)

In the final portion of the project, MRI scans were evaluated to calculate joint surface forces. This work is currently underway. Research in humans has shown that MRI is an accurate measure of joint surface forces in the human knee. Once this technique is perfected in horses, it can reveal very sensitive information on the structure and function of the horse's carpus. For instance, a young horse can be studied throughout its training and if the surface forces are found to be very high in one location of his carpus, then training might be manipulated so that the joint can adapt to those stresses, hopefully preventing joint injury.

Although this article gives an idealistic picture of future diagnostic methods to describe equine joint disease, all of this technology is available and currently being studied in the laboratory. It is the hope of the researchers that these techniques will be accepted as a means of reducing the incidence of joint injury and catastrophic injury that plague the horse racing industry. The ultimate goal of personnel in the EORL is to evaluate a large number of diagnostic tests, such as nuclear scintigraphy, CAT scans, MRI, gait analysis and blood and joint fluid tests to determine those tests that are most appropriate for predicting, diagnosing and monitoring of joint disease in horses.

## Figures

Figure 1. Carpal joints (knee) from a cadaver specimen showing the biomechanical testing that was performed to determine articular cartilage thickness and joint surface forces.

Figure 2. A 3-dimensional computer model of an equine carpus derived from the cadaver study. The yellow lines indicate ligaments in the model, and the red lines indicate the tendons and muscles that apply force to the joints.

Figure 3. A computer model of the surface forces (A) and articular cartilage thickness (B) from the carpal bones of a cadaver specimen. This data can also be obtained from Magnetic Resonance Images performed on the live horse.