MAGNETIC RESONANCE IMAGING IN THE HORSE: AN INTRODUCTION
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Magnetic Resonance imaging has been available in the human field since 1977 and has been used in horses since 1997. Many of the same concepts of cross-sectional imaging that CAT scan images utilize can be considered with MRI. However MRI has many unique characteristics that allow for varied examinations. Magnetic Resonance Imaging takes advantage of the unique characteristics of hydrogen protons within the body to produce a very detailed image of both the hard and soft tissues. By alternating how the tissue is magnetized, different characteristics of the area can be examined. A typical examination is composed of a variety of sequences that magnetize the tissue in different planes as well as with different magnetization protocols. This allows the veterinarian to examine for inflammation, edema, anatomical abnormalities or other irregularity in the signal for both bone and soft tissues.

Physics of MRI:
Magnetic Resonance results from the effect of magnetic properties of atoms found in tissues. Protons consist of a nucleus containing both protons and neutrons. Electrons orbit the nucleus resulting in a spinning motion that is specific to each element. Since hydrogen is the most common element located within the body of mammals, it is the element with the most recognizable and useful magnetic moment. When an animal is placed in a strong magnetic field, the magnetic spins which are normally randomly oriented align in the direction of the magnetic field. A short pulse of high energy radio-frequency is applied and this disrupts the alignment of the hydrogen atoms. As the atoms re-align in the magnetic field, they emit a very small radiofrequency wave, that is captured and interpreted as the signal from the tissue. This is then transferred to a computer which transforms the raw data into a two dimensional representation of the tissue.

Application in the horse:
There are currently two main ways that MRI is applied to the horse. This can be broken into high and low-field systems and standing and recumbent positioning. A “high-field” system is defined as a system with >1.0 T (Tesla) magnetic field. A “low field” system is one less than 0.5 T. Mid –range magnets exist but are not commonly used in equids. High field systems produce a higher detail image in a more rapid time than low field systems, but currently all require general anesthesia. Low field systems can be used from certain manufacturers in a standing configuration, but have lower quality images and can require much longer acquisition times for the same sequences as the high field magnet. In general the stronger the magnetic field, the better quality the image and the more quickly it can be acquired allowing for more sequential imaging of the patient.

Currently the regions that can be examined with the MRI at Alamo Pintado Equine Medical Center are as follows. This list represents the typical “region” that is examined at each exam:
- Foot
- Fetlock
- Cannon region - i.e. suspensory ligament, tendons and ligaments
• Carpus
• Hock
• Head
• Cranial cervical
• Stifles – dependent upon horse size, shape and measurement characteristics

Imaging Protocols:

Imaging protocols or sequences are the basic building blocks of the MRI exam. There are three fundamental examination sequences with some minor variations that are applied to each protocol that make up almost all of the examinations. These are:

• Proton Density – show clear anatomic structure
• T2 weighting – show high fluid contrast
• T1 weighting – good definition of bone structure

Variations to each sequence type can be made to highlight specific tissues, or to retard specific tissue types allowing better visualization of other structures. Examples of these are (not an all inclusive list, but these are what are used in horses):

• Short Tau Inversion Recovery (STIR) – High contrast, low clarity with a reduction in the signal returned from fat and an increase in the signal from water.
• Fat-suppression (FS) – eliminates signal from fat from within the structures examined allowing for differentiation of other tissues that may be obscured by the fat (i.e. bone marrow)
• Water-excitation (WE) – excites water within the structures and results in a net loss of fat signal and an accentuation of water. Provides increase clarity.

Many other variations for sequence generation exist and there are numerous sequences and types of scanning protocols available that go beyond the scope of this lecture. Further information can be found online at http://www.cis.rit.edu/htbooks/mri/ for the advanced reader or in “Equine Surgery - third edition” pg 946-963

The typical scanning protocol used for an equine foot includes the following sequences and planes:

• Single plane localizer – used to find the foot in the magnet
• Three plane localizer – used to refine the positioning of the following imaging protocols
• Dual echo (proton-density (PD) and T2 weightings) in an axial plane
• Dual echo (PD and T2) in a sagittal plane
• T1 VIBE Fat saturation (FS) in an axial plane
• T1 VIBE FS in a sagittal plane
• T1 VIBE in a dorsal (frontal ) plane
• T2 STIR in an axial plane
• T2 STIR in a sagittal plane
• Proton Density Fat Saturation in an impar axial plane

This protocol sequence requires approximately about 30 minutes per foot using a 1.5 T magnet (Siemens Magnetom Espree). Typically both feet are examined to allow for comparison requiring about an hour of total anesthesia time.