New Concepts in Standing Advanced Diagnostic Equine Imaging

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KEYWORDS

• Standing computed tomography • Standing low-field magnetic resonance imaging • Equine

KEY POINTS

- Standing magnetic resonance imaging (MRI) and computed tomography (CT) eliminate the need for general anesthesia, reducing risk to the patient and cost to the client.
- Standing MRI of the carpus and tarsus distally is well described; diagnostic MR images are often comparable with high-field MR images.
- Standing CT of the equine head and distal limb has been successfully performed at a limited number of institutions where CT scanners are modified to accommodate the standing horse.
- Standing CT and high-field standing MRI will possibly become more available for horses in the near future.

INTRODUCTION

This article addresses the clinical application of magnetic resonance imaging (MRI) and computed tomography (CT) as applied to the standing equine patient. This discussion includes the logistics, advantages, disadvantages, and limitations of imaging a standing horse. In addition, a brief review is given of the physics of these modalities as applied in clinical practice, as well as the currently available hardware and software required by these techniques for image acquisition and artifact reduction. Finally, the appropriate selection of clinical cases for standing MRI and CT is reviewed, focusing on cases that are capable of undergoing standing surgeries following lesion diagnosis.

BENEFITS OF ADVANCED DIAGNOSTIC IMAGING IN THE STANDING HORSE

The benefits of imaging the standing equine patient include elimination of general anesthesia, increased availability of standing magnets, and, in most cases, reduced

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cost to the client. Arguably the most important benefit of standing diagnostic imaging is that it negates the need for general anesthesia and eliminates the associated risk to the patient. Anesthetic complications in horses are well described. The most common perioperative (and perianesthetic) complications include cardiac arrest, fractures in recovery, and myopathy. One study performed to evaluate the risk of general anesthesia in horses undergoing MRI found the mortality rate to be 0.6%,[1] which is similar to that of healthy horses undergoing nonabdominal surgeries.[1–3] Interestingly a greater proportion of horses suffered myopathy after MRI (2.3%) than after surgery (0.8%).[1] In this study, horses in the MRI group were heavier, whereas horses that underwent surgery had longer anesthetic duration. The increase in myopathy in horses undergoing MRI was not statistically significant, which the investigators attributed to the limited power of the study. Nonetheless, it was concluded that the 8 cases of myopathy seen in the MRI group versus 2 in the surgical group may represent a clinical difference. In a multiinstitutional study assessing the risk of general anesthesia in horses, it was shown that the likelihood of patient death increases if the duration of anesthesia exceeds 61 minutes.[3,4] Anesthesia time for an equine patient to undergo a recumbent MR examination of bilateral distal forelimbs in a 1.5-T magnet is approximately 1 to 2 hours. Although sedation is required to perform an MRI or CT examination on a standing horse to limit patient motion and protect the patient and equipment from damage, the need for general anesthesia is eliminated, thus making standing imaging a lower-risk procedure than recumbent MR or CT imaging.

In general, high-field (recumbent) MR examinations are often more costly than their low-field counterparts. High-field magnets are built to produce a stronger magnetic field than low-field magnets, thus providing higher-resolution images. However, this benefit comes at a price. High-field magnets are more expensive than low-field magnets to purchase and maintain. Because of the increased strength of their magnetic field, high-field magnets require a large room with conductive material built into the walls, termed a Faraday cage, the purpose of which is to protect the surrounding areas from the stray magnetic field produced by the magnet and to prevent stray radiofrequencies, such as radio waves, from interfering with the function of the magnet and quality of the images produced. The need for the large room to accommodate the size of the magnetic field, and the Faraday cage, adds to the expense of high-field MRI. By eliminating the need for general anesthesia with standing diagnostic imaging, the overall cost of the procedure is inherently reduced.

STANDING MRI IN THE HORSE

Magnetic Field Strength and Magnet Configuration

MR scanners can be in either an open or closed configuration (**Fig. 1**). Until recently, high-field magnets required a closed (tube-shaped) configuration to produce a stronger magnetic field than low-field magnets. This closed configuration limits the size of the patient that can be imaged. Closed magnets with a wider-bore diameter (71 cm) and magnets with shorter bore lengths (125 cm long) and flared ends have been developed to accommodate larger human patients and claustrophobics. These developments have helped to improve the ease of positioning and to accommodate the larger and more proximally located anatomy of equine patients. However, regardless of bore length or size, general anesthesia is required to position a horse in the closed bore of a high-field magnet. Open magnets have a C-shaped configuration whereby the anatomy to be imaged is only partially enclosed (**Fig. 2**). It is this open configuration that allows for an MR examination to be performed on horses in the standing position. The open magnets that can be used to image standing horses are of low field strength at present.