

The Role of MRI/MRA in Abdominal Trauma

Scott B. Reeder, MD, PhD
Department of Radiology
University of Wisconsin, Madison, WI

Overview: Abdominal MRI is a rich modality with multiple contrast mechanisms including T1, T2, dynamic contrast enhanced imaging, diffusion weighted imaging, and quantitative and qualitative perfusion imaging. It has been demonstrated to be an excellent imaging modality for imaging of the abdominal vasculature as well as solid organs of the abdomen, particularly the liver, pancreas, kidneys, adrenal glands and spleen. In recent years it has also been demonstrated to be excellent method for imaging the small bowel and colon. MRI is the primary advanced imaging modality for pelvic imaging and continues to play an important role in the management of prostate cancer.

However, to date MRI has played a very limited role in abdominal trauma. Computed tomography (CT), and to a lesser extent ultrasound (US) have been the primary imaging modalities in the acute setting, and CT has become the primary imaging modality after surgery or during watchful waiting. While CT and ultrasound will continue to play a primary role in the acute setting of the “golden hour,” MRI can and should play an increasingly important role in the subsequent follow up of trauma patients after the golden hour. In this lecture, I will describe potential uses for abdominal MRI in the evaluation of trauma patients after the golden hour, during which the majority of cross sectional images are performed.

The Golden Hour: In the immediate minutes and tens of minutes after acute blunt or penetrating trauma of the abdomen, resuscitation of patients and rapid diagnosis of abdominal injury is paramount to patient management. The identification and assessment of internal hemorrhage and other parenchymal injuries is of paramount importance. Time is of the essence and gaining access to MRI scanners in an emergent fashion is generally impractical, for several reasons: 1) while many emergency departments have CT scanners nearby, many do not have easy access to MRI scanners or MRI technologists waiting on standby for trauma studies. 2) it is often impossible or impractical to perform the necessary safety screening of trauma patients. 3) it is often necessary to have the surgical trauma team close at hand, often inside or just outside the scan room, making screening of greater importance and the risk of projectiles a major hazard. While rapid MRI protocols of the abdomen could easily be performed with scan times similar to that of the CT, trauma patients often undergo whole body scanning including the head, spine, chest, abdomen, pelvis and occasionally extremities, all within a single scanning session. For these reasons of accessibility, safety, and the need to scan multiple body parts in rapid succession, CT remains the “king” of trauma imaging during the golden hour.

After the Golden Hour: Patients undergoing evaluation for internal injury with initial imaging studies follow one of several pathways: 1) no intraabdominal injuries are identified and no further work up is pursued, 2) severe injury necessitates surgical intervention. For these patients, there may be a need for subsequent follow up with cross sectional imaging either CT, US, or MRI. However, this is traditionally performed with abdominal CT, and in many cases, repeated studies, often numbering in the teens or twenties are performed, representing a significant radiation dose, often in younger patients. Subsequent follow-up imaging with MRI to evaluate for post-surgical complications may be highly appropriate, and in fact, may be the preferable

imaging modality. CT is often used simply by default and the fact that the original injury was evaluated with CT. 3) In other patients, more subtle injuries may be detected such as a small amount of intraabdominal blood or small liver/splenic laceration. The extent of the injuries may not warrant surgical intervention and patients fall into an algorithm of “watchful waiting.” In such patients, multiple follow up studies in the subsequent days and weeks may be performed, again with significant radiation dose. Given MRI’s high spatial resolution and multiple contrast mechanisms that make it very sensitive to detection of injury, MRI may play an important role in the management of trauma patients in a watchful waiting algorithm.

Advantages of MRI over CT: One of the most obvious advantages of MRI over CT is its lack of ionizing radiation. As will be discussed in the lecture, patients undergoing multiple repeated follow up studies, particularly with CT angiography (CTA) may easily experience *hundreds* of milliSieverts of radiation, much of could be avoided for subsequent follow up. For example, patients with subtle intimal injuries of the aorta may enter into a watchful waiting algorithm to determine the extent of the aortic injury and whether endostent placement or open repair is warranted. In addition, patients who have undergone endostent placement, often have multiple follow-up studies in the days, weeks, and months following the endostent placement to look for migration as well as the presence of endoleaks. MRA is an excellent method of evaluation of endoleaks after endograft placement, as good or better than CTA.

Other advantages of MRI include the rich armamentarium of techniques with multiple contrast mechanisms. As we will discuss in this lecture, the use of time resolved MRA to evaluate for arterial venous malformations or arterial-venous fistulas will be discussed. MRI and MRCP are well known to provide superior non-invasive evaluation of the bile ducts as well as exquisite sensitivity for the detection of abdominal fluid collections such as hematomas, seromas and bilomas. In addition, with the recent introduction of hepatocyte specific contrast agents such as Gd-BOPTA and Gd-EOB-DTPA, MRI provides excellent opportunities to evaluate for the integrity of the biliary system with *functional* test that allows for accurate evaluation of bile ducts, strictures or bile leaks. Using these agents, the ability to differentiate between hematoma, seroma, and biloma is a tremendous strength of MRI compared to CT.

Other advantages of MRI include tools such as diffusion weighted imaging or characterization of masses in fluid collections, for example the differentiation of an abscess from a simple fluid collection such as a seroma. Multiple examples of these different techniques including time resolved imaging of vascular injuries, endoleaks and other vascular abnormalities will be shown. Examples of liver and biliary trauma with identification of bile leaks and bilomas using hepatobiliary specific agents are also demonstrated.

Conclusion: While CT and ultrasound remain the imaging tests of choice during the golden hour, the subsequent management of patients after trauma, either post surgical or during a watchful waiting algorithm requires repeated advanced cross sectional imaging. Given the lack of radiation dose and the multiple tools in the MRI armamentarium, the use of MRI for post traumatic imaging is in the best interest of our patients, not only for determining of the most accurate diagnosis but also to avoid the accumulated radiation dose from multiple repeated exams, particularly in young patients.