An Integrated Neurovascular XMR Suite for the Clinical Treatment of Acute Stroke and other Neurovascular Diseases

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Abstract:

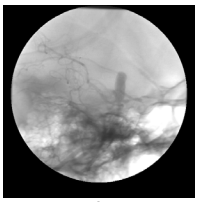
A fully functioning interventional XMR suite for the treatment of acute stroke and vasospasm patients using MR during thrombolysis treatment after an insertion of a catheter under X-ray guidance has been installed at MGH. To allow for quick and robust patient transport between these two modalities without having to lift the patient from one table to the other, a custom XMR transport system compatible with and capable of interfacing to both a SIGNA MR (GEMS 1.5 T NV/i) and an Omega-IV digital subtraction X-ray angiography pedestal (GEMS LCV+) as well as capable of transporting a patient from the intensive care unit or emergency area with full MR compatible patient life support and monitoring equipment was designed and installed. This approach minimizes both the time required to transport patients between the imaging systems as well as minimizing the risk of moving critically ill-patients and switching life support monitors. Clinical interventional neurovascular cases combining MR soft tissue contrast with catheter placement under X-ray guidance show good potential for improving outcomes with no MR artifacts due to the close proximity of the X-ray angiography system in the suite.

Methods

Combining the high quality 3D anatomical information obtained from MR with the high spatial and temporal resolution 2D images of x-ray imaging is of potentially great benefit in acute stroke monitoring and treatment as well as other neurological diseases whose treatment requires a short interventional time window. The ability to quickly interleave an MR exam with an angiogram, without leaving the procedure suite and without undergoing multiple bed transfers, enables rapid physiologic feedback on the results of the procedure. The XMR suite is particularly well suited to treating large vessel occlusive strokes because of the short time window for effective thrombolytic therapy of ischemic stroke available to these patients[1],[2]. Should the treatment be incomplete or an adverse event is detected, treatment could be restarted more quickly and more easily if the fluoroscopy and MR equipment were close to each other and if multiple bed transfers were not required. The XMR patient transport system minimizes risk of undesired removal of indwelling catheters as well as risk factors associated with transferring acutely ill patients between beds and radiological imaging tables. Clinical trials have begun combining catheter placement under x-ray guidance for thrombolysis treatment of acute stroke following MR based perfusion-weighted (PWI) and diffusion weighted (DWI) imaging diagnosis.

Results:

The modified trolley and table produce high quality images on both the MR and X-ray modalities. X-ray 3D spin acquisitions, which were acquired in a field less than the earth's magnetic field, showed no distortion due to the presence of the MR. Initial clinical trials with stroke patients on both the MR and X-ray side have yielded good results. Patients undergoing elective neurointerventional procedures, such as a balloon test occlusion, also benefited from a non-invasive assessment of brain physiology whilst the balloon is inflated (during the procedure) to look for undesired regions of abnormal perfusion as well as regions of ischemia due to the planned arterial occlusion.



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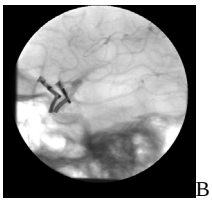

B

Figure 1: X-ray angiogram showing an aneurysm (A) and the excellent contrast necessary for guidance and placement of clips (B). Physiologic and morphologic brain information from an MR evaluation were already acquired before and following endovascular procedure. Included in the existing MR exams were assessments, such as diffusion imaging (Fig. 2), which measured the physiologic impact of ischemia. The ability to quickly interleave an MR exam with an angiogram without leaving the procedure suite and without undergoing multiple bed transfers enabled rapid physiological feedback on the results of an interventional procedures.

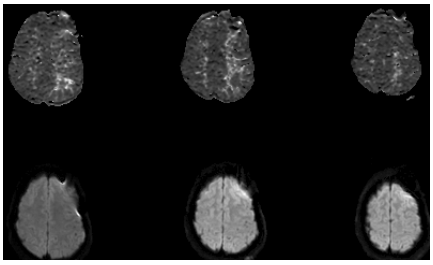

Figure 2: Patients undergoing neurointerventional procedures such as a balloon test occlusion benefited from a non-invasive assessment of brain physiology while the balloon is inflated during the procedure to look for undesired regions of abnormal cerebral blood volume (CBV) in a PWI scan, (top) as well regions of ischemia, with DWI due to the planned arterial occlusion. The physiological information also guided improved balloon sizing and placement. Similarly, patients with vasospasms often experienced regional perfusion changes and ischemia resulting from contracting arteries. Both diffusion and perfusion EPI sequences were unaffected by the close proximity of the x-ray imaging equipment as well as patient life support infrastructure. The combination of MRI with angiography in an interventional suite allows sufficient high sensitivity of detecting both intracerebral hemorrhage and ischemia within offset of symptoms and can identify the hypoperfused brain tissue showing potential occlusion of major arteries with x-ray guidance in the placement of catheters for thrombolysis treatment.

Conclusions:

The addition of MR monitoring to neurovascular procedures normally done under X-ray with the ability to quickly interleave an MR exams with an angiogram, without leaving the procedure suite and without undergoing multiple bed transfers promises the potential to improve outcome in time critical stroke procedures.

References:

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