

X-Ray Fused with Magnetic Resonance (XMR) Imaging for Accessing the Portal Vein

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Purpose: We evaluated the use of real-time X-ray imaging fused with MRI (XFM) to guide interventions targeting the portal vein. This technique uses roadmaps from MRI-derived data to provide roadmaps during conventional X-ray fluoroscopy.

Methods: Experiments were performed in a dedicated interventional MRI/X-ray suite equipped with a state-of-the-art Siemens Espree MRI scanner and AXIOM Artis dFC. Prior to imaging, jugular access was obtained in adult swine. After placement of multimodality external fiducial markers over the abdomen, low resolution, axial 3D gradient echo images (2.7x2.7 x 5mm) were acquired for marker visualization and contrast-enhanced, 3D T1-weighted gradient echo imaging (1x1x1mm) was performed for high resolution isotropic (1x1x1mm) imaging of the portal vein. Following MRI, the animal was transferred to a calibrated fluoroscopy system, while the portal vein was manually segmented from the MR images. Segmented regions of interest (ROI) from MRI data were transformed from 3D to 2D to correlate with gantry and table position and combined with live X-ray images using custom-built fusion software¹. After segmentation of the portal vein, the portal vein was subsequently merged onto live fluoroscopic images for guidance. Using a standard, Rosch-Uchida set, transjugular portal vein punctures were performed using this XFM technique. In addition to the transjugular approach to the portal vein, the XFM images were also used to perform a percutaneous portal vein puncture using a 22 Ga needle.

Results: Image overlay of the portal vein with real time fluoroscopy was feasible. After the two modalities were fused using the fiducial markers, unrestricted gantry rotation, table panning, and magnification changes were possible during the procedures. Variations of the portal venous anatomy could be readily identified and projected onto fluoroscopy. MRI roadmaps improved operator accuracy and orientation of needle pass from the hepatic vein. Registration errors were decreased when all the external fiducial markers were readily identified and therefore provided high spatial accuracy. With the image fusion, a single pass allowed immediate access to the portal vein from a transjugular approach and allowed access to the portal vein in 1-2 passes by the percutaneous route.

Conclusion: These results suggest that fusion of MR images with live fluoroscopy is feasible and can facilitate access into the portal vein from a transjugular and percutaneous approach.

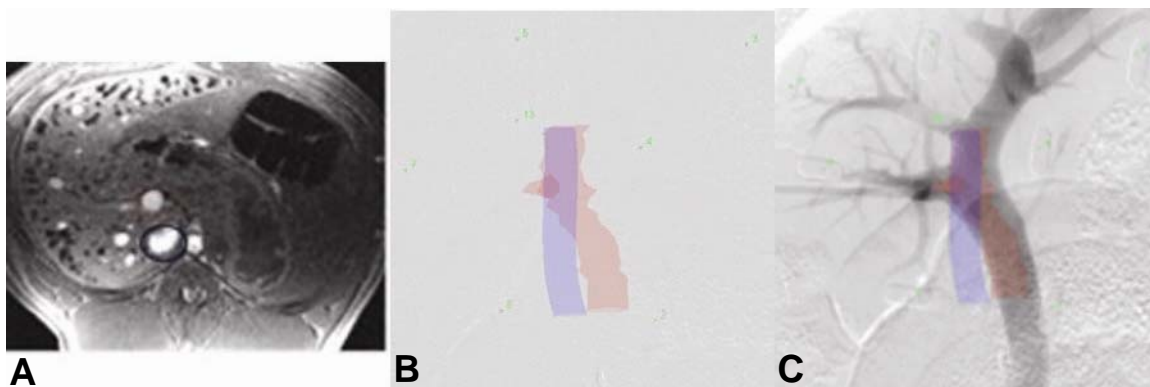


Figure 1. Images from X-ray imaging fused with MRI (XFM) guiding interventions targeting the portal vein. Panel A is a sample MRI GRE image with segmented ROI around the portal vein (red) and around the IVC (blue). Panel B demonstrating the transformed 3D MRI data projected onto the 2D fluoroscopic image correlating with gantry and table position. Panel C demonstrates a portal vein injection showing the correlation of actual anatomic position with the projected images.

References: 1) de Silva, Lederman, et al. *Circulation*. 2006 Nov 28;114(22):2342-50)