

Thesis Abstract:

This body of work explores the development and application of quantitative angiographic tools for 4D flow MRI and 2D-digital subtraction angiography (DSA). A novel quantitative tool was created to calculate blood velocities using time resolved 2D DSA acquisitions in the abdomen. The application of the quantitative DSA tool was used to assess intra-procedural blood velocity changes during transarterial embolization, which is frequently utilized to interrupt blood flow to an organ or lesion, including the treatment of liver tumors. In addition to quantitative DSA, 4D flow MRI was utilized to evaluate blood flow and velocity changes in a porcine liver model before and after transarterial embolization. Beyond the abdominal applications, a cranial 4D flow MRI post processing tool was developed to simplify and automate the analysis steps required for quantitative hemodynamic imaging within the brain, which is important for patients with cognitive diseases. Another area that 4D flow MRI could prove useful was in the realm of renal cell carcinoma to provide quantitative hemodynamic information for presurgical planning with potential implications on patient outcomes. Through rigorous theoretical analysis, phantom studies, and, in vivo testing, strides were taken forward to provide quantitative hemodynamic information that can complement anatomical angiographic imaging.