Measuring CSF Shunt Flow with MRI Using a Flow Sensitive MRI Technique

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Introduction

An estimated 50% of shunts placed to treat hydrocephalus in pediatric patients fail within two years and require repeated neurosurgical operation. (Hydrocephalus Association). Malfunction due to blockage and infection prevents drainage of cerebral spinal fluid (CSF) and increases risk for patients. Methods are needed to non-invasively evaluate the functionality of a shunt, providing a means to monitor its performance. We have performed a preliminary study on an MRI-based technique that can monitor, non-invasively and quantitatively, the slow flow of fluid through the shunt to determine its continued functionality.

Methods

We adapted a cerebral blood flux measurement technique using MRI called FENSI (Magn Reson Med, 2012) to measure the very slow flux of CSF through a shunt. CSF shunt flow was simulated using a large cylinder phantom, with a fluid-filled shunt (35mm long ventricular catheter (Medtronic REF No. 46118)), and a 5ml syringe (BD) being actuated by an MRI-compatible Harvard Apparatus pump. The shunt was wrapped to intersect the imaging plane twice enabling two measures to be performed at one time. We examined measurements of flow at several different flow rates (0, 0.1, 0.2, 0.3, 0.4 ml/min).

Results

The Mean Flow Measured Value shown in Figure 1 gives the mean (over time) value of the tag/control subtraction in the location of the two shunt positions. The flow should be the same between the two shunts and they do show good agreement between the measures. Next steps are to incorporate calibration and identify the lower limit to detectable flow.

Conclusions

In this work, we performed preliminary testing on an MRI technique that can perform non-invasive measurement of slow flows that would occur in CSF shunts. We have demonstrated high sensitivity to flow and will next extend the technique to measuring shunt flow in

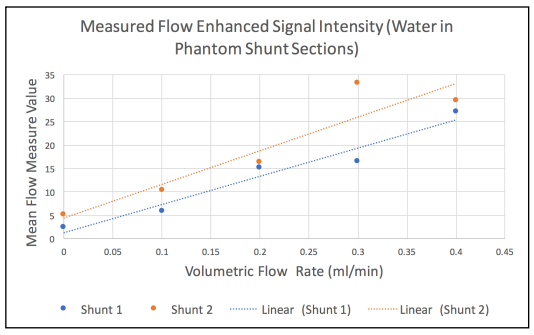

Figure 1: CSF phantom flow measured from shunt phantom. CSF Flow Measure Value is the measure (arbitrary units) after subtraction of the tag and flow image from FENSI. It can be quantified to absolute flow rate.

Learning Objectives

Learn about a new MRI technique to measure csf flow in shunts.

References

Ouyang c, Sutton BP. Localized Blood Flow Imaging Using Quantitative Flow Enhanced Signal Intensity: Magnetic Resonance Medicine 2012:March 67(3):660-68