Development of Improved Treatment Options for Hydrocephalic Patients

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Abstract. The current treatment of hydrocephalus involves removing excess cerebrospinal fluid (CSF) from the ventricular system using a pressure based system. However, existing shunt technology is characterized by high failure rates, and many revisions are necessary during the course of the disease. Direct measurements of ventricular volume may improve indications of the disease state and treatment options. The technique to measure volume consists of an impedance based technique that correlates an electric potential distribution as a function of volume. Before fabrication of our sensor, we perform computer-aided design and finite element simulations to infer design decisions. Once design parameters are obtained, the sensor is fabricated using polyimide catheters, platinum electrodes and a parylene-c coating. The characteristics of the sensor are obtained in bench-top gel models matching the properties of the brain. Knowledge gained from the bench-top is used to design preliminary animal experiments in conjunction with the University of Chicago. Juvenile rats were induced with hydrocephalus and the sensor with an internal shunt was implanted into the enlarged cerebral ventricles. CSF was removed and the dynamic measurement was recorded. The sensors, in conjunction with our bench top brain models, indeed show progress towards continuous volume measurements. These measurements are the first towards a novel treatment option for hydrocephalic patients.

Project Overview. Reconstructed images from subjects are used in the design of the sensor, frame A. Simulated measurements can be assessed for optimal design and placement of volume sensor shown in frame B. The sensors are fabricated using biocompatible materials. Frame D shows an implanted sensor in a normal weanling rat, as well as an MRI showing electrode artifact. Preliminary animal measurements demonstrate feasibility of the novel treatment option.

References: