FS 120

NPH patients in Bern – gold standard in therapy and its shortcomings

Christian Fung, Dept. of Neurosurgery, Inselspital Bern, Bern, Schweiz, christian.fung@insel.ch
Jürgen Beck, Dept. of Neurosurgery, University Hospital, Inselspital Bern, Bern, Schweiz

Normal pressure hydrocephalus, with an incidence of approximately 5.5/100,000, is a potentially reversible cause of dementia and impaired gait. The pathophysiological mechanisms are nebulous. Typically it is characterized by the triad of gait disturbance, urinary incontinence and memory impairment.
Standard criteria for the diagnosis of NPH are lacking. A combination of clinical evaluations (e.g. timed up and go test, tab test, external lumbar drain), imaging studies (e.g. ventriculomegaly, cerebral blood flow assessment, aqueductal CSF flow assessment) and possibly CSF dynamics tests (e.g. resistance to CSF outflow) lead to the diagnosis of NPH.
The standard treatment for NPH is ventriculo-peritoneal shunting. Up to 96% of patients report the subjective impression of overall improvement. On global objective rating scales (e.g. mRS) 65-77% of patients show an improvement. Impaired gait improves best with 83-89% improvement rate, 65-70% of patients present an improvement in incontinence and 44-48% on a test of memory. There is a possible decline of benefit of shunting over time. The risk for a serious adverse event is up to 22% and up to 30% of patients require at least 1 shunt revision. Complications include subdural hematomas (5%), shunt obstruction (17%), malpositioned distal catheter (3.5%), CSF infection (2.5%), malpositioned proximal catheter (1%) and intraventricular hemorrhage (0.5%).
The risks and benefits of shunting for NPH patients should be carefully weighed and discussed by the patient and treating physician.

FS 123

FEM modelling for bioimpedance controlled monitoring of Normal Pressure Hydrocephalus

Carlos Castelar, Medizinische Informationstechnik, RWTH Aachen University, Aachen, Deutschland, castelar@hia.rwth-aachen.de
Steffen Leonhardt, Medizinische Informationstechnik, RWTH Aachen University, Aachen, Deutschland

Hydrocephalus patients experience an accumulation of cerebrospinal fluid (CSF) in the ventricular space, usually associated with an increased intracranial pressure (ICP). In Normal Pressure Hydrocephalus (NPH), however, the ICP is not permanently elevated. In most cases, the therapy of choice is to implant a shunt to drain CSF from the ventricles through a passive pressure valve into another body compartment, like the abdomen. Common problems associated with the shunt therapy are over- and underdrainage. A bioimpedance system which monitors ventricular volume directly may help avoid these complications. It may also provide the possibility to use the volumetric information as an additional control parameter for an automated smart shunt. The envisioned sensor consists of six electrodes integrated on a drainage catheter surface.
The feasibility of the bioimpedance ventricular volumetry system has been evaluated using Finite Element (FE) anatomical models of the human brain obtained from an MRI dataset. A tetrahedral grid was generated and imported to COMSOL Multiphysics for processing. Tissue conductivity and permittivity were accounted for. Furthermore, in-vitro measurements have been performed using an Agilent LCR meter E4980A with agarose-gel and silicone-gel as parenchym phantoms. A current of 5 mA at 1 kHz to 1 MHz was injected and different voltage measurement configurations considered. Saline water was used as CSF substitute.
FEM simulations and in-vitro results show a reproducible negative correlation between measured impedance and ventricular volume. The measurement system is to be further validated using in a novel test bench for bioimpedance measurements of the craniospinal space, as well as by analysing the influence of CSF pulsatility.

FS 124

MRI flow measurements and what they tell us about hydrocephalus

Olivier Balédent, Directeur de l'équipe de recherche BioFlowImage, Université de Picardie Jules Verne, Amiens, Frankreich, benninghaus@hia.rwth-aachen.de

For a long time, CSF flows was mainly associated to continuous secretion and resorption flows. Knowledge of neuro-hydrodynamics has benefited considerably from the introduction of phase contrast magnetic resonance imaging (PC-MRI), which can provide CSF and blood flow measurements throughout the cardiac cycle. CSF, blood, and tissues interact in different kind of compartments (large, narrow, rigid, and compliant) associated inside the cranio-spinal system to different pressures: high pressure for arterial blood or low for the venous blood and the CSF. CSF motions results from cranio-spinal compliance and arterial and venous flows in the central nervous system. All these interactions generate intracranial pressure changes during cardiac cycle and mean that CSF and blood flows could depict the biomechanical state of the central nervous system. Hydrocephalus is the first pathology pointing CSF flow alterations: it is easy to identify a ventricular dilation in the brain it is more difficult to identify the origin of the dilation and find the good strategy to treat it when it is a pathological dilation! For many years, in collaboration with clinicians, we added PC-MRI sequences in the standard MRI protocols to bring complementary information about neuro-hydrodynamics' diseases. We study CSF flow, venous and arterial blood flows to identify and understand the potential origin of our hydrocephalus patients to help the neurosurgeons. The aim of this presentation is to expose a PC-MRI overview of our experience concerning normal and pathologic CSF and blood flows behaviors in the cranio spinal system.