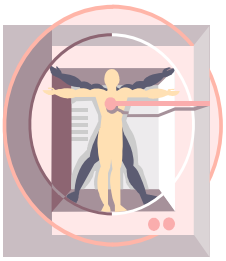
NJIT

Biomedical Engineering Department Seminar



Friday, February 9, 2007

Location: Cullimore Hall, Lecture Hall 3

Time: 12:00 - 1:00 PM

"Cerebrospinal Fluid Hydrodynamics"

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Objective: To better understand the fundamentals causes of flow dynamics of the cerebrospinal fluid (CSF), we created a compartmental analysis that quantitatively examines the role of cerebral tissue in generating and shaping normal circulation of CSF.

Background: Although great efforts have been made, the exact propelling mechanism by which the CSF moves through the ventricular system still remains undisclosed. The accepted paradigm assigns a simple and defined circulation to the CSF. Originating by a combined passive and active mechanism at the level of the choroid plexus in the lateral ventricles, CSF travels through the foramen of Monroe, the third ventricle, the Sylvius Aqueduct and fourth ventricle, where it exits the ventricular system into the cisterna Magna of the subarachnoid space; from here it continues filling the basal cisterns and to the convexity of the cerebral hemispheres; as well as inferiorly into the spinal subarachnoid space. CSF absorption into the venous sinus takes place mainly at the arachnoid villi.

Nevertheless, studies done by Naidich et al, with phase contrast cine MRI , challenge this simple concept by showing a complex pattern of normal CSF oscillatory flow between three compartments: ventricular, cranial and spinal subarachnoid space; his work also draws attention to the important relation between the cardiac cycle, brain-blood volume variation, and the movement of the CSF. Notwithstanding that a decrease in the compliance of the heart's ventricular wall is essential for blood ejection during systole, up to present very little interest has been dispensed to the relation between the bulk properties of the brain and the CSF circulation.

Altered circulation of CSF gives rise to hydrocephalus. Hydrocephalus is still defined as: "a dilation of the ventricular system caused by an imbalance in production and absorption of cerebrospinal fluid (CSF)". This definition confers a passive role to the interaction between the CSF and the brain parenchyma. It also implies that the bulk properties of the brain parenchyma remain unchanged, thus playing no role in the genesis of hydrocephalus. The present work takes into consideration this CSF flow pattern described by Naidich, cyclic variation of brain-blood volume due to high cerebral vascularization, the hierarchical organization of the brain tissue, and simple rules of flow and volume. An analysis of the conditions necessary for a normal CSF flow is done from a material science and engineering perspective. In an effort to better understand the CSF flow dynamics, a computerized model was developed.