A Series of *In Silico* Fluid Structure Interaction Simulations of the Cerebrospinal Fluid Pressure Wave Propagation in the Spinal Subarachnoid Space

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Full etiological explanation for craniospinal pathologies of the spinal subarachnoid space (SAS) has not yet been provided. In the case of Chiari malformation and related syringomyelia, it has been hypothesized that a cerebrospinal fluid (CSF) flow blockage in the SAS (stenosis) could play an important role in disease pathogenesis. In particular, the interaction of a spinal SAS stenosis and spinal cord tissue could result in abnormal CSF pressure distribution in the spinal SAS causing damage to the spinal cord tissue and, in the case of syringomyelia, contribute to syrinx (spinal cord cyst) enlargement. Detailed pressure measurements in the spinal SAS would be helpful to better understand the complex hydrodynamic mechanisms involved in craniospinal pathologies such as syringomyelia, but these measurements are typically require invasive measurement methods.

Thus, five 2-D axisymmetric *in silico* models were designed, in the finite element analysis platform ANSYS (ANSYS Inc., Canonsburg, Pa), to be representative of various craniospinal pathologies. The *in silico* models were constructed to be nearly identical to a similar set of *in vitro* models to help validate and understand the results. A transient impulse with duration of 5ms was applied at the caudal end of the spinal SAS in each *in silico* model. Fluid pressure and structural motion was determined *in silico* and compared to the axial pressure distribution measured *in vitro*.

Overall, the *in silico* pressure calculations and *in vitro* pressure measurements had similar distribution and propagation speed. In the *in silico* and *in vitro* experiments, the stenosis was found to have a major impact on the FSI of the spinal cord and stenosis. In all experiments, the stenosis acted to decrease pressure wave propagation speed, and attenuate SAS pressure fluctuations rostral to the stenosis (distal). Increasing compliance

(distensibility) of the spinal column slowed the SAS wave speed significantly. The similarities between the *in silico* and *in vitro* results help validate and further the development of similar FSI models representative of the spinal SAS.