A thorough analysis of intracranial dynamics takes into account the effects of cerebral vasculature on brain physics. In fact, cerebral blood flow has profound effects on overall physiological function and brain mechanics. Physiological functions of cerebral blood flow include the transportation of hormones throughout the brain and the removal of metabolic waste products from the brain. In addition, a large amount of cerebral blood supply is necessary to meet the metabolic needs of neuronal cells which require significant amounts of oxygen and glucose. The mechanical effects of blood are also profound. As blood traverses cerebral arteries, the arteries expand. This expansion causes CSF from the subarachnoid space to be displaced from the cranium into the spinal canal. The displacement of CSF into the spinal canal is necessary due to the volume consistency of the cranium and is possible due to the distensibility of the lower lumbar region of the spinal canal. Cerebral vasculature expansion also causes brain tissue strain leading to compression of the lateral ventricles and outflow of CSF from the ventricular system.

The numerous mechanical and physiological functions of cerebral blood flow and cerebral vasculature provides a basis for their inclusion in a computational model that seeks to quantify intracranial dynamics. The association of abnormal brain dynamics with circulatory disorders gives further support for including cerebral vasculature in mathematical models [1]. We believe an adequate understanding of the mechanics of cerebral blood flow will lead to greater insights about diseases such as arteriosclerosis, atherosclerosis, arteriovenous malformation, and even tumor growth. To this end, cerebral vasculature of normal subjects is being reconstructed using computer tomography (CT) images in Mimics. The mathematical models developed from the patient-specific image reconstruction will be used to better understand the interaction between pulsating vasculature and displaceable CSF in our holistic model of intracranial dynamics [2].

Left: CT angiography images and Mimics are used to reconstruct a patient’s cranial arteries/veins. Right: Reconstructed Circle of Willis with predicted blood pressure through the basilar artery.