# Cerebral Perfusion Analysis Using Computational Modeling of the Brain and its Arteries

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The cerebral region's ability to govern complex cognitive processing and functions of various organs in the human body is dependent on the ample supply of oxygen and nutrients to the brain through a dense network of cerebral blood vessels. Any narrowed or blocked cerebral vessels can cause ischemia, dementia, chronic migraines, and damage to the brain tissue. Thus, it is crucial to understand normal and abnormal brain perfusion along with contributions of blood vessels for analysis of cerebral diseases. The purpose of this research is to propose a 3D-modeling based methodology to simulate normal and abnormal cerebral blood flow and its correlation to brain perfusion. This study is focused on modeling two components of the cerebral region: cerebrovasculature and brain volume. First, MRI data of 8 subjects (5 F, 3 M; ages 21-63) were used to model cerebral blood vessels. Cerebral vessels were identified and segmented using custom software (SimVascular) for 3D-modeling and computational flow simulations. To seek optimal settings for hemodynamic simulations, boundary conditions were tested on the models, with both steady and pulsatile flow at the model inlets and resistance values at the model outlets. Cerebral vessels of all subjects were modeled, including major arteries such as the posterior cerebral arteries, superior cerebellar arteries, basilar artery, posterior inferior cerebellar arteries, and vertebral arteries. Next, the same MRI data was loaded to ITK-SNAP to segment the white matter of each brain. The vessel models were then co-registered to their respective brain models to identify the region of perfusion for each vessel end. Brain models were segmented by frontal lobe, occipital lobe, temporal lobe, parietal lobe, temporal lobe, and cerebellum. Co-registration of the blood vessels and brain models confirmed proximity between the posterior cerebral/vertebral arteries and the occipital lobe, the superior cerebral arteries and the midbrain, as well as the basilar/posterior inferior cerebellar/vertebral arteries and the cerebellum. This methodology was able to more closely study brain perfusion by modeling and simulating patients' cerebrovascular hemodynamics and brain tissue. Future works involve analysis of additional patient model constructions and implementation of 3D-printing for palpable visualization. This research's findings can contribute to comprehensive treatments of patients affected by cerebral diseases in clinical settings.