Overview

The purpose of this presentation is to provide an overview of (i) the importance of cerebral blood volume (CBV) measurements in health and disease, (ii) non-invasive MRI approaches available for measuring CBV, and (iii) application studies in the setting of basic physiology and disease that are actively being pursued using non-invasive CBV approaches.

Background

CBV, commonly reported in units of mL of blood / mL of parenchyma, reflects that amount of blood in the cerebrovasculature and is closely linked with cerebral blood flow (CBF) regulation, and in many instances neuronal activity. Briefly, active vasodilation is facilitated by microvascular smooth muscle cells surrounding arterioles which facilitate changes in vessel diameter to meet the local energy demands of surrounding tissue. By measuring such CBV changes, it is possible to gain information regarding hemodynamic demand, and ultimately to make inferences regarding neuronal activity. Therefore, like CBF, CBV mapping provides an additional way to measure regional changes in activity.

Total CBV quantification in humans is possible using invasive contrast agents and MRI, positron emission tomography (PET), computed tomography (CT) and single photon emission computed tomography (SPECT). However, non-invasive approaches for measuring CBV in humans would be useful for performing longitudinal studies of CBV regulation and for clinical studies aiming to incorporate patients with contraindications to contrast agents. Non-invasive MRI approaches for measuring total (VASO) and venous CBV (VERVE) response to neuronal stimulation have been proposed and arterial spin labeling (ASL) MRI approaches (QUASAR) are being modified to allow for CBV estimation as well.

Finally, the growth in availability of non-invasive CBV approaches should allow for mechanisms of brain activity to be probed in more detail. As MR approaches that require contrast agents are becoming more tightly regulated, the availability of non-invasive approaches will facilitate CBV to be mapped in a larger number of research and clinical studies, thereby
allowing for a better understanding of the role of CBV and its relation to neuronal activity, clinical presentation and functional brain imaging signals.

Outline
This presentation will be divided into the following sections:

I. Overview of cerebral blood volume (CBV)
   a. How CBV differs from CBF and normal ranges in healthy individuals
   b. Mechanisms by which CBV is regulated
II. Non-invasive techniques for measuring CBV will be presented, as well as an overview of popularity, strengths, limitations and quantification issues of each approach.
   a. Spin labeling based approaches (e.g. QUASAR)
   b. Blood water nulling approaches (VASO and iVASO)
   c. Other methods (VERVE and MOTIVE)
III. Applications of CBV imaging for better understanding neurovascular coupling and functional MRI contrast
IV. Clinical application of non-invasive CBV imaging (ischemic cerebrovascular disease and stroke, tumor and Alzheimer’s disease)

Expectation
This session should provide an overview of the physiological relevance of CBV, the available methods for imaging CBV without invasive contrast agents, and the state of the field for assessing altered CBV in health and disease using these approaches.