Changes in perfusion are the hallmark of many diseases that affect the brain. While neurovascular diseases, such as stroke and arteriovenous shunting lesions, may seem to be the only diseases associated with perfusion changes in the brain, in fact, many other common diseases will demonstrate either primary or secondary perfusion changes. In particular, the use of perfusion imaging in neurodegenerative disease and epilepsy are two conditions in which delineation of perfusion changes may be helpful for identification, prognosis, and treatment.

There is a long history of imaging brain perfusion, which begins with the whole brain measurements of Kety and Schmidt performed with nitrous oxide over 70 years ago. Methods using diffusible tracers are often considered gold standard methods, and these include 15-O water PET, stable xenon CT, and arterial spin label MRI. Other common methods include dynamic non-diffusible tracers, which stay in the vasculature, and which include dynamic susceptibility contrast (DSC) MRI and iodinated contrast-based computed tomography perfusion (CTP). Most recently, novel approaches to extract perfusion parameters, including cerebral blood volume and arterial transit delay, from resting-state functional MRI (rs-fMRI) have been described, which may turn out to be most useful of all, considering that additional information regarding brain connectivity is a potentially useful "side-benefit" of this method. All of these methods have strengths and weaknesses, which will be extensively discussed in this talk.

Furthermore, I will discuss how we use perfusion imaging as part of the clinical practice of radiology, to help us narrow our lists of possible diseases, to gauge severity, and to assess changes related to treatment. In particular, I will focus on both acute and chronic cerebrovascular disease, arteriovenous malformations and dural arteriovenous fistulas, neurodegenerative disease, epilepsy and other seizure-related conditions, and brain tumors. I will focus on most common uses, stressing practical tips for users interested in incorporating these new techniques into mainstream practice. For people with technical expertise in perfusion methods, I hope to point out compelling clinical scenarios and unmet technical needs.

Overall, perfusion imaging as an adjunct to anatomical imaging adds a new dimension to clinical MRI examinations. We will likely continue to see its increasing application for brain disorders, provided that proper attention is paid to developing methods that are accurate, reproducible, and robust.