Redefining MRI:
From Image to Insight

ICMRI 2026
THE 14th INTERNATIONAL CONGRESS ON MRI
& 37th ANNUAL SCIENTIFIC MEETING OF KSMRM

AUGUST 27 - 28, 2026
Grand Walkerhill Seoul, Seoul, Korea
https://icmri.ksmrm.org/2026m

Cardiovascular 1

SY20-3

Clinical Applications of 4D Flow MRI: A Neurologist's Perspective

Bum Joon Kim

Department of Neurology, Asan Medical Center, Korea

Intracranial atherosclerotic disease is a major cause of ischemic stroke, particularly in Asian populations. From a neurologist's perspective, the clinical value of vascular imaging lies not simply in identifying arterial stenosis, but in understanding why a vascular lesion causes stroke, whether it is responsible for the presenting event, and how it may contribute to future cerebrovascular events. Importantly, lesions with similar degrees of stenosis may have substantially different clinical consequences.

Our research has focused on the pathophysiological interaction between vascular geometry, local hemodynamics, and intracranial atherosclerosis. We initially demonstrated an association between middle cerebral artery geometry and the development of intracranial atherosclerosis, suggesting that local vascular configuration may influence the hemodynamic environment and plaque formation.

More recently, we combined high-resolution vessel-wall MRI with 4D flow MRI to investigate the relationship between plaque characteristics, local hemodynamics, and stroke mechanisms. Different mechanisms of ischemic stroke showed distinct spatial relationships between plaque characteristics and wall shear stress. In particular, artery-to-artery embolism was associated with greater spatial variability in wall shear stress and a characteristic relationship between hemodynamic stress and plaque activity. These findings suggest that the degree of luminal stenosis alone may be insufficient to characterize the clinical significance of an intracranial atherosclerotic lesion.

From a clinical perspective, diffusion-weighted imaging, vessel-wall MRI, and 4D flow MRI provide complementary information. Diffusion-weighted imaging demonstrates the pattern of ischemic injury, vessel-wall MRI characterizes the underlying arterial pathology, and 4D flow MRI provides information on the local hemodynamic environment. Integration of these imaging modalities may improve our understanding of the mechanisms by which individual intracranial atherosclerotic lesions produce cerebral ischemia.

Our recent observations also suggest that the relevance of cerebral hemodynamics may extend beyond large-artery atherosclerosis. Variations in middle cerebral artery geometry and wall shear stress were associated with cerebral small-vessel disease burden, raising the possibility of an interaction between large-artery hemodynamics and downstream microvascular injury.

In this lecture, I will discuss the potential clinical applications of 4D flow MRI from a neurologist's perspective, focusing on how hemodynamic information can complement conventional vascular and vessel-wall imaging in understanding stroke mechanisms and intracranial vascular disease.

Keywords: *4D flow MRI, Intracranial atherosclerosis, Wall shear stress, Vessel wall MRI, Cerebral hemodynamics, Ischemic stroke*