Carotid plaque imaging studies can aid in early diagnosis to help prevent TIA and stroke.

Compared to other imaging modalities, MRI has advantages in carotid plaque imaging.
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“Atherosclerotic vulnerable plaque in the carotid artery is believed to be one of the major triggers for ischemic cerebrovascular events, such as transient ischemic attack and stroke. Therefore, early detection and characterizing the vulnerability of carotid plaque is valuable for primary and secondary prevention of ischemic stroke.

Xihai Zhao, MD, PhD, is using Achieva 3.0T TX for imaging atherosclerotic plaque. "Measuring luminal stenosis by angiographic techniques is still the main choice for assessing atherosclerotic disease severity. However, studies have shown that a substantial number of carotid arteries with low-grade stenosis develop high-risk features, such as intraplaque hemorrhage (IPH) and fibrous cap rupture," Dr. Zhao says. "As carotid high-risk features are associated with cerebrovascular events, early accurate detection of carotid high-risk plaque may play an important role in prevention of ischemic stroke. So, we are using imaging techniques for direct visualization of the arterial vessel wall and assessing plaque stability, rather than measuring luminal stenosis alone.”

MR an important modality for imaging plaque

Dr. Zhao is using MRI to non-invasively study carotid plaque. “MRI allows us to determine plaque size and identify main plaque compositions such as calcification, lipid-rich necrotic core (LRNC), and IPH. MRI acquisition allows variable imaging orientations, which helps to better visualize carotid bifurcations where most of the lesions occur.”
In addition, MRI can be used in serial studies with good reproducibility on measuring plaque burden and identifying tissue compositions. This has led to MR plaque imaging techniques being used in many clinical trials for monitoring the therapeutic effects after treatment with cholesterol lowering drugs.

**MR plaque imaging techniques**

For visualization of the vessel wall and characterization of plaque features, Dr. Zhao uses time of flight (TOF), and black blood proton-density weighted, T1W, and T2W scans. Using these sequences, major carotid plaque features, such as calcification, LRNC, IPH, and fibrous cap rupture, can be accurately identified, as has been verified with histological validations.

“MRI allows determining plaque size and identifying main plaque compositions.”

Dr. Zhao does not suggest applying all above plaque imaging techniques to all patients. “3D fast imaging sequences with large coverage are useful for examining high-risk patients. For detailed investigation of high-risk plaque features, the multi-contrast imaging protocol needs to be performed. For the analysis of carotid plaque MR images, the PlaqueView software package or similar image analysis software can be used.

**High risk atherosclerotic plaque in carotid artery**

In a 77-year-old male with 2-year history of ischemic stroke brain MR imaging had shown lacunar infarcts at left basal ganglia and left periventricular white matter lesions on T2W FLAIR images. On carotid plaque MR imaging a high-risk plaque with ulceration (thick arrow) and intraplaque hemorrhage (IPH; thin arrow) is seen at proximal segment of the left internal carotid artery (star). IPH appears hyperintense on both TOF and T1W images and is more sensitively detected by the 3D T1TFE sequence (bright signal). Severe luminal stenosis was developed due to the lesion progression. This high-risk lesion is well visualized on MPR of 3D TOF images.

CCA = common carotid artery. The findings suggest that aggressive therapeutic strategies, such as endarterectomy, need to be conducted for prevention of recurrent stroke. Achieva 3.0T TX was used.

“3D T1-TFE has been used to successfully identify IPH with higher sensitivity and specificity, compared to TOF and T1W imaging⁴, as demonstrated in the clinical cases with this article,” says Dr. Zhao.

“Most plaque imaging is done using 2D acquisitions – such as T1W, PDW, and T2W – which allow limited longitudinal coverage centered in the carotid bulb within acceptable scan time.

Dr. Zhao says, “We currently explore newly developed 3D MERGE, a MSDE prepared rapid gradient echo sequence, which offers the advantages of 3D acquisition, isotropic matrix size (0.7 mm³), larger longitudinal coverage (> 120 mm) and shorter scan time (2 minutes)⁴. We believe this could be a good option for fast carotid plaque imaging.”
“3D fast imaging techniques with large coverage are useful for examining high-risk patients. For investigation of high-risk plaque features, the multi-contrast imaging protocol needs to be performed.”

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