THE UNSTABLE CAROTID ARTERY PLAQUE

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Each year, there are approximately 1 million strokes in the European Union, making it by far the most common neurological disorder. Approximately 25% of men and 20% of women can expect to experience a stroke if they live to be 85 years old, and stroke is the second most common cause of death worldwide. The total incidence of stroke is projected to increase by 50% the next 20 years because of the rapid increase in the elderly population, and it is predicted that stroke will account for 6.2% of the total burden of illness in 2020.The prevention of cerebrovascular disease therefore represents a major goal.

A significant proportion of strokes are thromboembolic in nature, arising from atherosclerotic plaque at the carotid bifurcation. Such strokes have been shown to be effectively preventable by carotid endarterectomy. In current clinical practice patient selection for revascularization primarily involves identification of the severity of luminal stenosis. This is usually measured using conventional imaging modalities such as Doppler ultrasound, intra-arterial digital subtraction angiography or MR or CT angiography.

It is however increasingly clear that the degree of luminal stenosis alone may not be the best predictor of risk. Owing to the process of arterial remodelling, the lumen of an artery may not be compromised despite the presence of significant atherosclerotic burden. Strokes may occur as a result of non-stenotic carotid disease, and conversely, a non-negligible proportion of patients with significant carotid stenosis may remain completely asymptomatic throughout their life-time.There has thus been considerable research in developing imaging modalities which may identify in vivo certain key morphological and molecular features which are associated with increased risk.

Structural imaging using 3.0 Tesla MRI and dedicated carotid coils: Carotid plaques can be assessed using 3.0 Tesla MRI and dedicated surface coils carotid coils. These examinations are then assessed using MRI software which can automatically assess total plaque burden and plaque composition such as intraplaque hemorrhage (IPH), a lipid-rich necrotic core, the amount of calcification, loose tissue and the fibrous cap.

Imaging of macrophage activity: Inflammation is fundamental to lesion progression in atherosclerosis and the macrophage is the key cellular mediator of this process. Detection of macrophage activity and hence inflammation within atheroma can therefore potentially distinguish between unstable and stable states and this remains one of the key targets of atheroma imaging. Several approaches have shown good promise in achieving this objective. Resident plaque macrophages have been successfully imaged using MRI and ultra-small particles of iron oxide (USPIO). USPIOs consist of microcrystalline magnetic cores coated with dextrans or siloxanes with typical diameters of <50 nm which act as a 'negative' contrast agent by, in effect, generating heterogeneities in the magnetic field that can be detected on MRI as signal voids.

Imaging of metabolic activity: Positron Emission Tomography (PET) is another approach to image inflammation and metabolic activity within the atherosclerotic plaque. Fluorine-18-labelled fluorodeoxyglucose (FDG) is a PET radiopharmaceutical that enters metabolically active cells through the same mechanisms as glucose. FDG is however not fully broken down by the enzymes of the cell and therefore accumulates in proportion to metabolic activity.

Microembolus detection: Transcranial Doppler (TCD) may be used to detect asymptomatic cerebral microemboli which have their origin in an ipsilateral carotid plaque. This is possible because an embolus causes an increase in the amount of reflected ultrasound compared to that normally caused by red blood cells. The detection of cerebral microemboli in patients with both symptomatic and asymptomatic carotid plaques strongly suggests that the plaque has become unstable and that the patient has an increased stroke risk compared to embolus negative patients. A consequence of these microemboli is silent infarcts which may be detected using diffusion-weighted MRI.