CHARACTERISATION OF CAROTID STENOSIS WITH MAGNETIC RESONANCE DIRECT THROMBUS IMAGING IN PATIENTS WITH TRANSIENT CEREBRAL ISCHAEMIA

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Introduction

Thromboembolism from atheromatous disease within the carotid arteries is the major predisposing cause of cerebral ischaemia. Recent results of large multicentre trials have shown the benefit of surgical intervention in those patients with significant (>70%) carotid stenosis. The ability not only to assess carotid narrowing but also morphological changes at the site of narrowing may allow further lesion characterisation resulting in improved risk stratification prior to surgery. Patients at high risk though without marked stenosis may also be identified allowing alternative treatment options. Thrombosis is associated with this process of atherothromboembolism, as both a cause of plaque rupture, when intra mural, and as a result of plaque rupture when intraluminal. Plaque containing haemorrhage/thrombus is defined as complex causing a much higher rate of cerebral ischaemic events. The ability, therefore to identify acute carotid thrombus in the setting of cerebral ischaemia may allow the accurate identification of symptomatic carotid disease. Similarly demonstration of symptomatic carotid disease in the absence of accepted indicators such as significant stenosis would also allow improved selection of patients for surgical or medical therapy. In this study we have applied a novel magnetic resonance imaging (MRI) technique (1) that allows the demonstration acute carotid thrombus in patients being assessed for carotid surgery in order to correlate the prevalence of carotid thrombus with symptomatic disease. In addition, the MRI images have been compared with histopathological appearances allowing the precise identification of the components causing the MRI signal changes.

Material and Methods

Following ethical committee approval and informed consent, 15 patients who were being assessed prior to carotid surgery were imaged. All were known to have significant carotid stenosis (>70%) proven by ultrasound. Imaging was performed on a 1.5T scanner (Siemens, Erlangen) using a receive-only phased array cervical spine coil. Magnetic resonance imaging comprised of FLAIR brain images, phase contrast cerebral angiography, contrast enhanced or time of flight carotid angiography and direct thrombus imaging.

The direct thrombus imaging technique employed a T1 weighted magnetisation prepared 3-D gradient echo (MPRAGE) sequence using a selective water excitation RF pulse, acquired in the the coronal plane (TR 10.3, TE 4.0, FA 15, TI 20, FOV 350 x 300, matrix 256 x 140, 140 partitions, one acquisition, bandwidth 195Hz per pixel). The number of partitions and TI were chosen such that the middle lines of k-space, ie effective TI, occurred at a time to null blood. This took into consideration the incomplete relaxation afforded by the delay time (TD) of 1000ms that was used. The resulting scan acquisition was just over five and half minutes long.

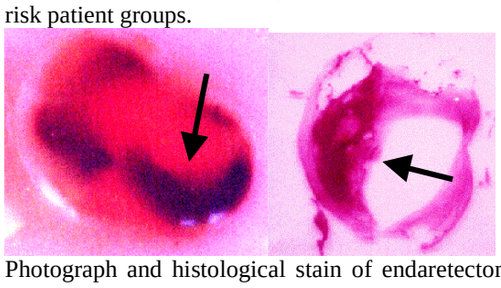
The presence of carotid stenosis was graded using the NASCET criteria. Acute thrombus was diagnosed if high signal material was seen within the wall or lumen of the carotid artery. Following surgery the carotid endarterectomy specimen was sectioned and photographed followed by routine histological staining.

Results

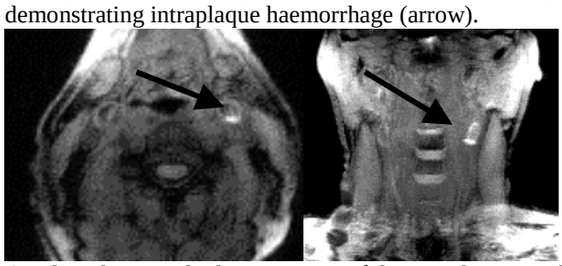
Pathological analysis of the specimens demonstrated intraplaque haemorrhage in 10; 5 had single large regions of haemorrhage, 2 smaller multiple regions and 3 single small foci. The MRI and pathological appearances agreed in 14/15 (93%) cases (figure 1). In one patient a small region suggestive of haemorrhage was seen on MRI but not confirmed on histology. In all the patients undergoing scanning a 70% or greater degree of carotid stenosis was confirmed by MRI.

Discussion

This study confirms that the vast majority of patients presenting with symptomatic carotid disease have areas of high signal intensity intimately associated with the region of carotid narrowing demonstrated using this newly described MRI technique. Comparison with histological study of the excised carotid disease shows these areas of high signal to represent haemorrhage/thrombus. While bilateral disease does exist the abnormal signal was associated with the side of transient cerebral ischaemia in 93% of cases. The results therefore suggest that the presence of haemorrhage/thrombus in association with carotid stenosis is a useful marker as to the potential of that disease to cause symptoms. The presence of high signal detected by this technique could possibly be used to identify patients with recurrent symptoms but degrees of stenosis below the currently accepted levels required for surgery. These patients may then be suitable candidates for medical therapy that modifies the behaviour of atheromatous plaque. We have previously reported (2) the presence of similar carotid disease in patients presenting with acute stroke, and in a proportion of these carotid stenosis was not severe (<70%). These cases therefore confirm that stenosis in isolation is not necessarily a good marker of carotid disease activity. However, complex plaque may be a better marker and techniques such as the one described here to identify this form of atheromatous disease may be more accurate in identifying at risk patient groups.



Photograph and histological stain of endaretectomy specimen demonstrating intraplaque haemorrhage (arrow).



Axial and coronal clot imaging of haemorrhage in the left carotid artery (arrow)

1. Moody AR. Lancet 1997; 350: 1073.
2. Moody AR, Allder S, Lennox G, Gladman J, Fentem P. Lancet 1999; 353: 122-123

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