Magnetic Resonance Direct Thrombus Imaging of the carotid plaque is associated with increased thromboembolization

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Background

Magnetic Resonance Direct Thrombus Imaging (MRDTI) has been shown to identify the histological complicated carotid plaque (1). This T1-weighted technique visualizes met-hemoglobin present in areas of intraplaque haemorrhage and thrombus found within the complicated carotid plaque (fig.1). However the true thromboembolic activity of the plaque may not always be reflected by the histological assessment of the carotid plaque (2). One surrogate marker of thromboembolic activity is micro-embolic signals (MES) detected by ultrasound. Clinically silent microembolic signals identified using Transcranial Doppler (TCD) have been noted in 30-40% of patients with symptomatic carotid stenosis. Microembolic signals predict subsequent ischaemic cerebral symptoms (3) and in the dissection phase of carotid endarterectomy they are associated with unstable carotid plaque and operative stroke (4).

The purpose of this study was to ascertain whether MRDTI can predict the thromboembolic potential of the carotid plaque.

Methods

Ethics committee approval and informed consent was obtained for all patients recruited. 32 patients with symptomatic carotid artery disease (carotid stenosis greater than 60%) were enrolled between October 2003 and September 2004.

MR imaging was performed on a 1.5 T scanner (Siemens). The MRDTI sequence used a T_1-weighted magnetization-prepared 3D gradient-echo sequence, acquired in the coronal plane. The sequence included a selective water-excitation radio frequency pulse to abolish fat signal, and the effective inversion time was chosen to null the blood signal. The pixel size and effective slice thickness were 1.2 mm. Assessment of the images involved reading of coronal and axial sources. A positive scan was diagnosed if high signal material (brighter than the adjacent muscle) was seen within the wall or lumen of the carotid artery in the region and 1 cm to either side of the stenosis.

TCD recordings were made from the middle cerebral artery ipsilateral to the carotid stenosis via the transtemporal route. All recordings were made using a TCD ultrasound (SciMed) machine with a 2-MHz probe for 1 hour immediately pre – carotid endarterectomy and during the dissection phase of the operation. The dissection phase was defined as the time from the start of the operation (i.e. skin cleansing) up to the clamping of the carotid arteries. The Doppler signal was recorded on digital audio tape and analyzed offline.

Results

Of the 32 patients recruited, 6 did not have an adequate window for TCD monitoring. Of the remaining 26 patients, 18 were classed as MRDTI +ve and 8 as MRDTI –ve. The mean period between the MRI and the operation was 36.4 days (range 1 to 81). There were no significant differences between the major demographic features or vascular risk factors between these 2 groups (chi-square, $p>0.05$).

TCD monitoring detected spontaneous particulate embolization in 9 patients. Combining all emboli (from the preoperative and dissection phases) 8 patients with MRDTI +ve plaques and 1 patient with MRDTI –ve plaque had emboli (range 1-11) (chi-square, $p=0.13$).

When just the dissection phase emboli were assessed; 8 patients with MRDTI +ve plaques had emboli (range 1-11) and no patients with a MRDTI –ve plaque had any emboli (chi-square, $p<0.05$).

Conclusions

This study provides preliminary data to suggest that MRDTI signals of the carotid plaques is associated with spontaneous particulate embolization. The uncomplicated carotid plaques as defined by MRDTI –ve appearances were found not to have MES in the dissection phase of the carotid endarterectomy. In contrast, almost half of the MRDTI +ve carotid plaques did show TCD detectable microemboli in the dissection phase. If confirmed in a larger sample, this provides an important validation of the usefulness of MRDTI as surrogate marker for the risk of future stroke. In particular the MRDTI –ve status may be a powerful predictor of a reduced risk of spontaneous microembolic stroke which may improve the selection of patients undergoing carotid endarterectomy.

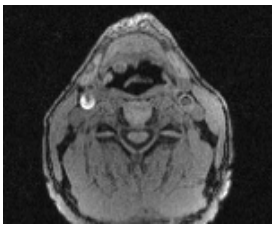

Fig.1. Axial image of the carotid arteries using MRDTI. The right carotid artery has a hyperintense MRDTI positive plaque

References

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