Cerebrovascular consequences of carotid stenting with & without a neuroprotection filter

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Introduction: Percutanious transluminal angioplasty in combination with vascular stenting aims to reduce the risk of stroke in patients with severe internal carotid artery (ICA) stenosis. However, such intervention carries risks associated with procedural microembolisation. Intravascular neuroprotection devices (in the form of a porous 'umbrellas', designed to capture fragments of atherosclerotic plaque prior to entry into the cerebrovasculature; fig 1) have been devised with the aim of reducing such procedural risks. The purpose of this work was to monitor the cerebral consequences of the deployment of an intravascular neuroprotection device during the stenting procedure using MR perfusion and diffusion imaging in the short and medium term following intervention.

Methods: Thirty patients with symptomatic ICA stenosis were recruited. Each was randomly assigned to either receive the neuroprotection device (NeuroShield^{TM} filter, Abbott Medical, Illinois, USA) or not (15 in the 'protected' and 15 in the 'unprotected' groups). If deployed, the shield was inserted distal to the stenosis and expanded prior to angioplasty, stent insertion and expansion. MR was performed at 1.5T (Eclipse, Philips Medical Systems) on 4 separate occasions: 24 hrs pre-procedure; <3 hrs post-, 24 hrs post- and 1 month post-procedure. The presence of focal ischaemic injury was assessed on each occasion via diffusion-weighted images (DWI) and maps of apparent diffusion coefficient (ADC) calculated from data obtained using a single-shot spin-echo diffusion-weighted sequence (b-values 0 and 1000 s/mm^2). Parenchymal perfusion was assessed using a multi time point, single shot T2* weighted EPI sequence (TE_{eff}=60ms; TR=1.4s; 70 time-points). A 20ml bolus of gadolinium diethylenetriamine pentaacetic acid (Magnevist, Schering) followed by a 20ml saline flush was administered intravenously by a power injector at 5ml/s starting on the 10th time-point. Post-acquisition perfusion data processing was as described previously yielding figures of merit for interhemispheric asymmetry in first moment mean transit time (ΔTT_{FM}) and regional cerebral blood volume (ΔrCBV) (1).

Results: ***Diffusion****:* Three protected and 4 unprotected patients missed one scan each whilst 3 protected and 2 unprotected patient missed two scans each. The overwhelming majority demonstrated no new lesions on DWI/ADC maps. All new lesions were ipsilateral to the treated carotid artery: 9 in the protected and 4 in the unprotected groups following intervention (up to and including the 30 day scan). This difference between groups was not statistically significant. ***Perfusion****:* Those patients with only one completed scan episode (one unprotected patient) and those with no completed scans (one protected patient) were excluded from analysis. In MCA territory, as expected, the bolus transit time was initially longer on the symptomatic side. There was significant reduction in the degree of interhemispheric asymmetry from baseline to each post-stenting time-point ($p<0.005$). This reduction in asymmetry was noted as early as the immediate post-stenting scan episode (≤ 3 hours) and was sustained through the 24-hour and 30-day time-points. There were no significant differences between any of the post-stenting scan episodes. There was a significant reduction in the degree of interhemispheric asymmetry in rCBV from baseline to the immediate post-stent scan episode ($p<0.05$). This relationship was not present at 24-hours but was evident again at 30-days. There were no significant differences in rCBV between any of the post-stenting scan episodes. Both protected and unprotected groups follow the same pattern of change in the degree of interhemispheric asymmetry. There was no statistically significant difference between protected and unprotected groups (Fig 3) on either of the 2 perfusion measures.

Discussion: New white lesions were detected in both groups that remained clinically silent. There was no significant difference between the two groups although there were more new white lesions in the protected group. Carotid stenting effects a rapid reduction in degree of interhemispheric TT_{FM} asymmetry within territory supplied by the ICA's that is felt as early as 1-3 hours post intervention and is sustained as far as 30-days post intervention. The interhemispheric rCBV asymmetry demonstrates no discernable pattern of change. Within the sensitivity range of the measurement technique, the presence of the cerebral protection filter does not adversely effect cerebral microhaemodynamics or the incidence of abnormalities in parenchymal water diffusivity.

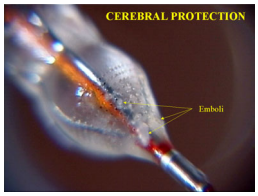

Figure 1 The intra-arterial neuroprotective shield after PTA / stenting. Note the presence of trapped embolic material.

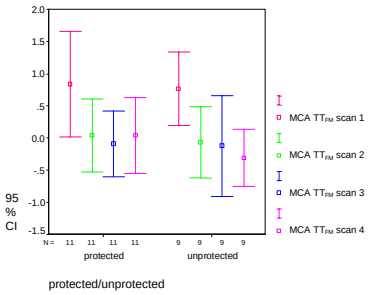

Figure 3. Mean interhemispheric asymmetry in TT_{FM} at each time point for the protected and unprotected groups. The differences between pre-intervention (1st scan) and each of the post-intervention (2nd, 3rd and 4th) scans were statistically significant ($p<0.005$).

References:

1. Wilkinson ID *et al.* AJNR 2003; 24(8):1501-1507.