Altered flow territories after extracranial to intracranial bypass surgery: clinical implementation of selective arterial spin labeling MRI.

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Introduction

To preserve cerebral perfusion after carotid sacrifice by therapeutic carotid occlusion and to augment cerebral perfusion in patient with atherosclerotic internal carotid artery (ICA) occlusion extracranial to intracranial (EC-IC) bypass surgery can be performed. Until recently no imaging technique could demonstrate flow territory supplied by the bypass after surgery. Recently, magnetic resonance regional perfusion imaging (RPI) was introduced, in which selective labeling of the major brain feeding arteries (ICAs, posterior circulation or bypass) was used for flow territory mapping with a direct anatomical correlation.[1] We present the first patient series with selective arterial spin labeling MRI for flow territory and CBF measurements.

Methods

Seven consecutive patients (mean ± SD age; 52 ± 15 years; 6 male, 1 female) with an atherosclerotic ICA occlusion (n = 4) or a giant aneurysm of the ICA (n = 3) in whom a high flow EC-IC bypass and a permanent occlusion of the ICA was performed were included in this study. Planning of selective arterial spin labeling is demonstrated in figure 1. Inversion with RPI is achieved by applying two consecutive slice-selective 90° RF pulses. A delay of 1200 ms was used to allow the blood to flow to the tissue. Other RPI parameters: TR = 3000 ms; TE = 5.6 ms; 62% half Fourier acquisition; number of slices = 5; slice thickness = 8 mm; slice gap = 1 mm; FOV = 240 × 240 mm; matrix = 64 × 64; zero filling to 128 × 128 matrix; averages = 30; RPI scan time = 3 minutes. Figure 2 demonstrates flow territory images.

Results

No significant difference was found in CBF between the hemisphere ipsilateral to the EC-IC bypass (70.9 ± 11.3 ml/min/100gr tissue), contralateral to the EC-IC bypass (71.9 ± 14.3 ml/min/100gr tissue) and CBF in a series of 50 healthy control subjects (69.1 ± 17.5 ml/min/100gr tissue). Paired analysis of the individual flow territories demonstrated a 15% volume reduction (P=0.018)) in flow territory of the EC-IC bypass compared to the flow territory of the contralateral ICA (average flow territory maps shown in figure 3).

Discussion and conclusions

Selective arterial spin labeling MRI shows in each individual patient whether the EC-IC bypass can augment cerebral hemodynamics demonstrating the brain tissue feeded by the EC/IC bypass and the CBF of the corresponding area.

[1]*Hendrikse J, Stroke. 35:882-887.*

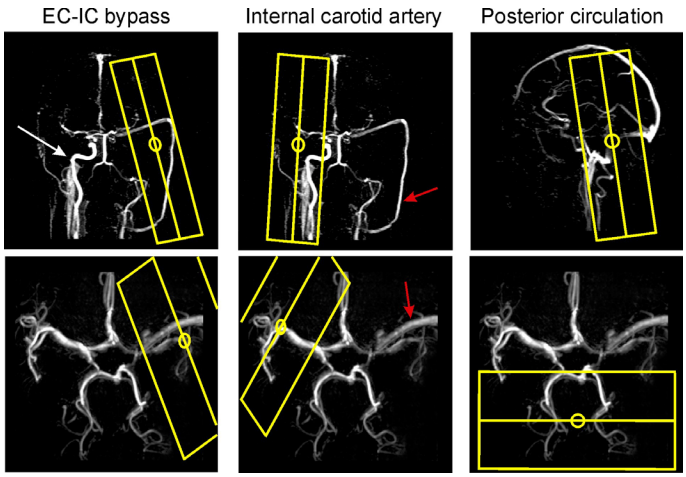

FIGURE 1. *Scan plan for selective labeling and flow territory mapping of the EC-IC bypass, right ICA and posterior circulation. The oblique sagittal labeling slab for selective labeling of the EC-IC bypass and the ICA was planned using a coronal phase contrast survey MRA in combination with a MIP image of the circle of Willis. The coronal labeling slab for selective labeling of the posterior circulation was planned using a sagittal phase contrast survey MRA in combination with a MIP of the circle of Willis. Arrow head indicates right ICA; arrows indicate EC-IC bypass.*

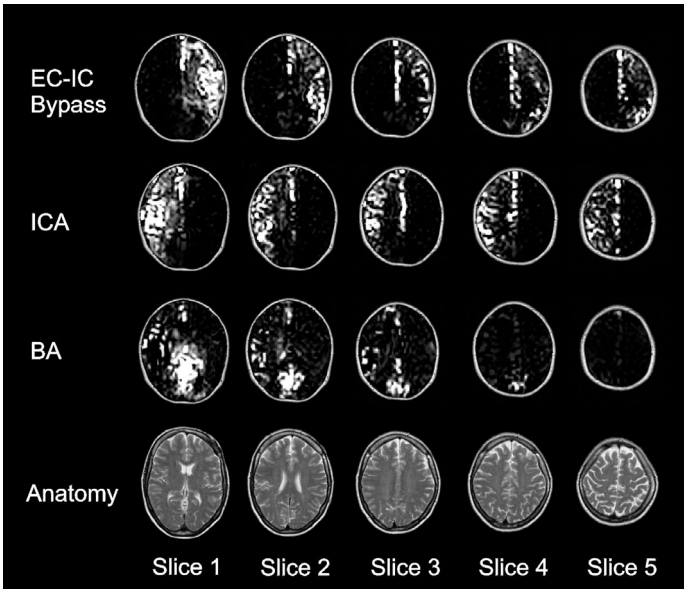

FIGURE 2. *Flow territory images (ml/min/100gr tissue) according to RPI labeling of the left sided EC-IC bypass, right sided ICA and posterior circulation (basilar artery and vertebral arteries) with corresponding anatomical images (patient 5). When using oblique sagittal RPI labeling of the EC-IC bypass or the contralateral ICA, the flow territory of the basilar artery is excluded and no perfusion-weighted signal is present in the posterior part of the imaging slices. When using coronal labeling of the posterior circulation, perfusion weighted signal is symmetrically present in the posterior part of the imaging slices. However, some labeling contamination of the ICA is still present as artfactual bright signal in the ICA flow territory. In this particular case, the flow territory supplied by the bypass is of similar size compared with the flow territory supplied by the contralateral ICA.*

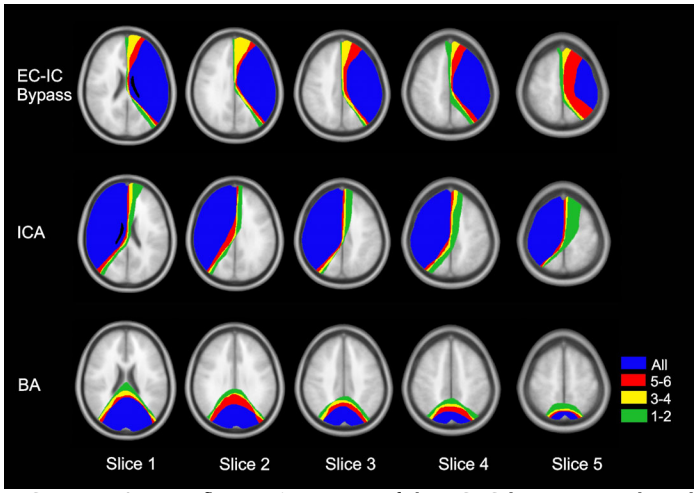

FIGURE 3. *Average flow territory maps of the EC-IC bypass, contralateral ICA and posterior circulation for the seven patients. Flow territory maps are projected to a standard Talarach brain. The maps of the top, middle and bottom row indicate the overlap of the flow territories of respectively the EC-IC bypass, contralateral ICA and posterior circulation. The dark grey area indicates maximal overlap, flow territory present in all seven patients.*