Introduction
Dynamic susceptibility contrast MRI (DSC-MRI) is a technique that is well suited for imaging of cerebral perfusion in clinical practice. Multiple slice, high-resolution images of regional cerebral blood volume (rCBV), mean transit time (MTT), time of appearance (TA), and time to peak (TP) are acquired. A major disadvantage of the method is that relative values are obtained. Quantitative data can be derived by deconvolution with the arterial input function. However, this approach is not feasible for patients with carotid occlusive disease, since the actual input function cannot be measured reliably. Therefore, in these patients, perfusion abnormalities can be detected only by considering the contrast with the surrounding tissue or, more commonly, with the contralateral hemisphere. These restrictions have prohibited reliable perfusion data of patients with bilateral carotid artery disease using DSC-MRI. We tested a new approach to investigate perfusion changes for patients with internal carotid artery (ICA) occlusions. Perfusion data were normalized over the cerebellum allowing comparison of patients with control subjects. The purpose of this study is to assess perfusion changes for patients with carotid occlusive disease by bilaterally comparing normalized perfusion data with control values.

Methods
Forty-four patients and thirty-three control subjects were studied. Patients were divided into three groups: patients with a unilateral ICA occlusion (group O-, n=19), patients with a unilateral ICA occlusion and a contralateral severe stenosis (>70%) (group OS, n=13), patients with bilateral ICA occlusions (group OO, n=12).

DSC-MRI was performed in five slices (4 through the cerebrum and 1 through the cerebellum), using a gradient echo, echo planar imaging sequence (TR/TE/α = 260ms/30ms/30°, time resolution = 1.5 s). Matching IR and T2-weighted images were obtained by using similar orientation parameters as DSC-MRI. Gray matter and white matter were segmented on the IR images and lesions were excluded on the T2-weighted images. Normalized perfusion data were calculated for each parameter by taking its ratio over the total cerebellum.

Results & Discussion
Figure 1 shows the normalized values of rCBV (1a,b), MTT (1c,d), TA (1e,f) and TP (1g,h) for white matter and gray matter respectively. The averaged values are shown for the control group (gray bars) and for the ipsilateral (black bars) and contralateral (white bars) hemispheres of the three patient groups. Significant differences of patients compared to control values are indicated.

The most important results are that, in the ipsilateral hemisphere of patients with carotid artery occlusions, rCBV, MTT, TA and TP were increased. In gray matter rCBV was increased only when both ICA's were occluded (OO). In white matter rCBV was increased in the ipsilateral hemisphere for all patient groups (O-, OS and OO).

In the contralateral hemisphere, we found that TA and TP were increased when a contralateral stenosis or occlusion was present, whereas MTT and CBV were increased only when the contralateral ICA was occluded.

Conclusions
The approach of comparing normalized perfusion data with control values proved feasible and reliable. It permits the study of hemodynamic changes in both hemispheres for patients with carotid occlusive disease.

References
1 Belliveau, J. et al., MRM, 14:538-549, 1990
3 Gückel, F., Brix, G., Rempp, K., Deimling, M., Röther, J., Georgi, M., JCAT, 18:344-351, 1994