Model-free arterial spin labelling CBF quantification using regional arterial input functions identified by factor analysis

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Introduction

Quantification of perfusion using model-free arterial spin labelling has been proposed by Petersen et al. [1]. To calculate cerebral blood flow (CBF), tissue signal curves sampled at high temporal resolution are needed and regional arterial input functions (AIFs) must be identified. Petersen et al. [1] presented regional AIFs selected on the basis of a threshold in the arterial blood volume map. In this study, we present another approach that takes the shape and the timing of the arterial signal time curve into consideration, i.e. factor analysis of dynamic studies (FADS) [2].

Material and methods

All examinations were performed on a 3 T Philips Achieva unit (Philips Medical Systems, Best, The Netherlands) using quantitative STAR labelling of arterial regions (QUASAR) [1]. After sequence optimization in five volunteers, one volunteer (female, age 31) was examined using slice thickness=7 mm, matrix =64x64, flip angle= 40°, TR/TE=3500/20 ms, $TI_1/\Delta TI$=50/300 ms, number of acquisition points=11, SENSE factor=1.5, inversion slab width=100 mm, $V_{enc}=[\infty, 4 \text{ cm/s}]$ and 60 pairs of control and labelled scans. The data were analysed using a locally developed computer program (Interactive Data Language, IDL 6.0, Research Systems Inc. Boulder, CO, USA). The raw images (control and labelled) were subtracted to create ΔM images. Two sets of images were retrieved, one without crusher (i.e. large-vessel signal differences were not removed), and one with crusher. Arterial signal curves were obtained by subtracting the crushed data from the non-crushed data, and arterial blood volume (aBV) was given by the total area of the arterial signal curve divided by the bolus area. AIFs can be obtained by choosing arterial signal curves with an aBV above a given threshold [1]. FADS is a technique that can be used to characterize different physiological properties of a system, and in the present study FADS was applied to the arterial signal curves as an alternative method to acquire the arterial input functions. Perfusion maps were obtained using block-circulant SVD deconvolution and regional AIFs (the nearest AIF is found for each voxel) obtained by FADS as well as by using an aBV threshold of 1.2%. CBF was determined in ROIs placed in grey matter (GM) and white matter (WM) in the CBF map obtained using regional AIFs identified by FADS.

Results

CBF in GM was 68 ml/(min 100 g) and CBF in WM was 26 ml/(min 100 g).

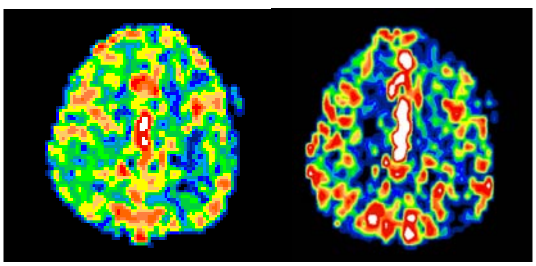

Figure 1. Parametric maps obtained in a healthy volunteer using dynamic ASL and regional arterial input functions retrieved using FADS. The CBF map is shown to the left and the aBV map to the right.

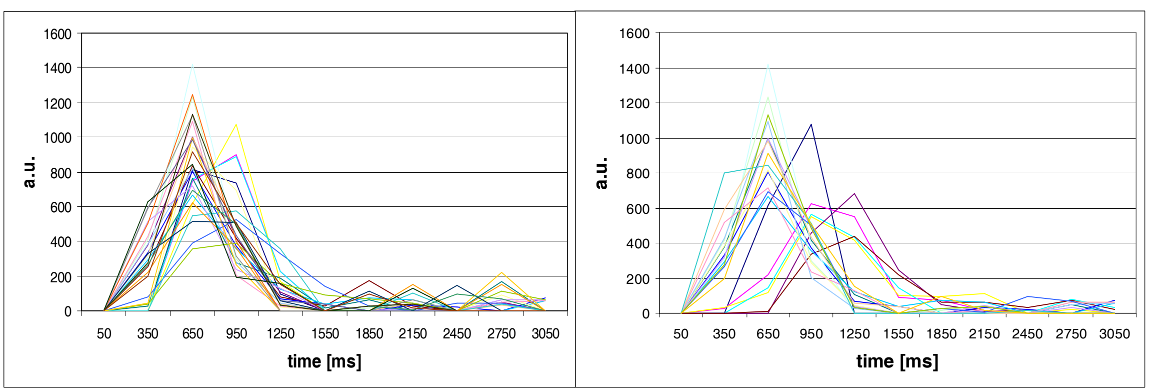

Figure 2. Regional AIFs obtained from one slice using FADS (left) and aBV thresholding (right).

Conclusions

Good CBF image quality as well as reasonable quantitative CBF values were obtained using the combined QUASAR/FADS technique. Furthermore, a larger number of regional arterial input functions were obtained when the FADS technique was used, compared to when the aBV threshold was used. Additionally, regional AIFs retrieved using FADS showed higher structural and temporal uniformity than those retrieved from the aBV threshold. We conclude that FADS may be a useful supplement in the evaluation of ASL data using temporally resolved methods such as QUASAR.

References

1. Petersen et al. Model-free arterial spin labelling quantification approach for perfusion MRI. Magn Reson Med. 2006;55:219-232.
2. Knutsson et al. Calculation of cerebral perfusion parameters using regional arterial input functions identified by factor analysis. J Magn Reson Imaging. 2006;22:444-453.