Evaluation of arterial input function for perfusion MRI: comparison with that of PET study

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Introduction:

Dynamic susceptibility contrast-enhanced magnetic resonance imaging (DSC-MRI) with bolus injection of Gd-based contrast agent provides brain perfusion images. Cerebral blood flow (CBF) and the mean transit time (MTT) of tracer can be determined when deconvolution is performed with an appropriate arterial input function (AIF) [1,2]. However, inaccuracy in the AIF measurement causes errors in CBF and MTT estimates. Thus, assessment of the AIF is crucial for quantitative perfusion study. To investigate accuracy of the AIF determined in DSC-MRI, we compared the AIF used in a DSC-MRI study (MRI-AIF) with that used in a positron emission tomography (PET) study (PET-AIF) in healthy volunteers.

Materials and Methods:

Subjects were seven healthy volunteers 20 or 21 years of age. DSC-MRI study with a bolus injection of Gd-based contrast agent and PET study with a bolus injection of $H_2{}^{15}O$ were performed for each subject on the same day. To compare MRI-AIF with PET-AIF, bolus injection time of the contrast agent in MRI and that of $H_2{}^{15}O$ in PET were set to be nearly the same (about 3 sec). The perfusion data were measured by a 1.5T Siemens scanner at 1-second intervals using a gradient echo EPI sequence [3]. After the start of perfusion scanning, 10 mL of Gd-DTPA contrast agent was injected into the antecubital vein by a power injector. The matrix size was 128×128, and the measured data were smoothed by a 3×3 uniform filter. The MRI-AIF was measured by a semiautomated method as follows [3]: A rectangular region of interest that covered the insular segment in the middle cerebral artery territory was drawn manually. For each pixel in the rectangular region, the bolus index, defined as the ratio of the peak height of the concentration curve to its peak time, (C_{peak}/t_{peak}) was calculated. The MRI-AIF was determined by averaging the 5 pixels in which the bolus index was largest. The PET-AIF was obtained by continuous measurement of arterial blood radioactivity with a beta detector after bolus injection of $H_2{}^{15}O$ through the antecubital vein. Delay and dispersion occurring in the beta detector system and the internal-arterial line were corrected by the established method [4]. Peak width (full width at half maximum) and time to peak MRI-AIF and PET-AIF were compared in the study subjects.

Results:

The MRI-AIF was successfully measured in all subjects. MRI-AIF and PET-AIF are compared in Figure 1. The shape of the MRI-AIF curve was similar to that of the PET-AIF curve except for volunteers 3 and 6. The average time to peak MRI-AIF was identical to that of PET-AIF: 14.9±2.2 sec for MRI-AIF and 15.1±2.0 sec for PET-AIF. The average peak width was 6.7±0.9 sec for MRI-AIF and 7.5±1.9 sec for PET-AIF. When two subjects (volunteers 3 and 6) who encountered minor technical problem in PET-AIF measurement were removed from the analysis, the average peak width of MRI-AIF was identical to that of PET-AIF: 6.7±1.1 sec for MRI-AIF and 6.5±0.4 sec for PET-AIF.

Conclusion:

The result of our study, that the shape of the MRI-AIF curve obtained from the gradient echo EPI sequence agreed with that of the PET-AIF, indicates that the combination of appropriate deconvolution and the present MRI-AIF method will provide accurate CBF and MTT images.

References:

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This research was partially supported by the Ministry of Education, Science, Sports and Culture, Grant-in-Aid for Young Scientists.

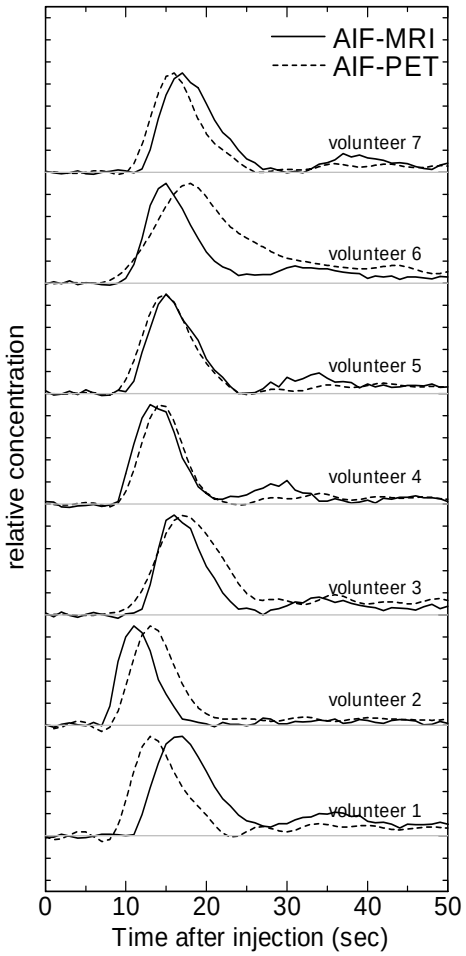

Figure 1. Comparison between MRI-AIF and PET-AIF. The concentrations were normalized by the peak value.