Cerebral hemodynamics evaluation by ACZ challenge DSC-MRI with VOF rescaling scheme

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PURPOSE

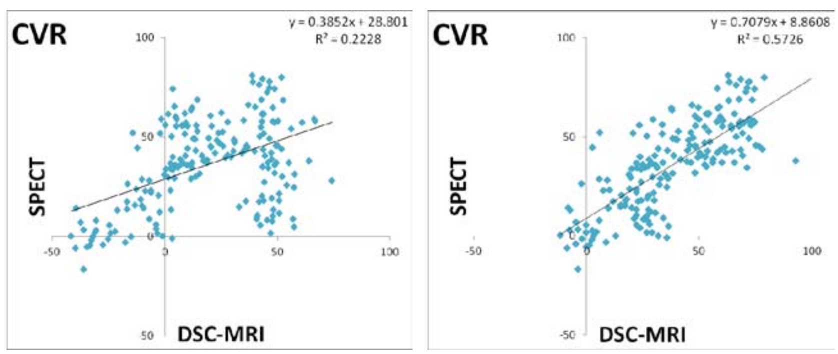
Cerebral hemodynamics evaluation is crucial in the management of acute and chronic cerebrovascular disease. For pre-surgical planning, acetazolamide (ACZ) challenge dynamic SPECT has been performed to estimate cerebrovascular reserve (CVR). Recently, dynamic susceptibility contrast MRI (DSC-MRI) can be used to evaluate the cerebral perfusion. We have attempted to evaluate CVR with ACZ challenge DSC-MRI, however it is difficult to assess CVR precisely. We hypothesize that the AIF variance between rest and ACZ challenge DSC-MRI is a potential problem. The AIF variance is caused by partial volume effect on small arteries and can be reduced by the AIF time integral rescaling scheme using a venous output function (VOF). Thus in this study, we adapted the VOF rescaling scheme over rest and ACZ challenge DSC-MRI data to evaluate CVR.

METHOD AND MATERIALS

Twelve patients (10 male and 2 female; 8 IC stenosis, 2 MCA stenosis, 2 Moya-moya disease) were included in this study. Rest and ACZ challenge dynamic ^{123}I-IMP SPECT were performed using a 1-day protocol. DSC-MRI was performed at 3.0 T with 8-ch head coil. DSC-MRI was performed with a 3.0T MRI unit. DSC-MRI data were obtained with single-shot 2D-GEEPI (TR/ TE/ FA = 1200/ 20/ 70). Sixty dynamic data were obtained at 1.2seconds time resolution during an intravenous bolus injection of Gd contrast agent. A 7.5mL of contrast agent was injected by MR compatible power injector at a rate of 3.0mL/s then a 20mL saline flush was administered. After the rest DSC-MRI, ACZ (1.0g) was administrated intravenously. Ten minutes later, ACZ challenge DSC-MRI was performed at the same manner of the rest study. Totally 15mL (7.5mL $\times$2) of contrast agent was used in this study. These DSC-MRI data were processed by perfusion mismatch analyzer (PMA; ASIST-Japan). PMA, which is dedicated software to DSC-MRI analysis, automatically decides AIF and VOF and generates cerebral perfusion parameter images including CBF with block-circulant singular value decomposition algorithm. VOFs of each study were set to equal on calculation. The CBF images of each DSC-MRI were normalized to the standard brain atlas and drawn ROIs (ACA, anterior MCA and posterior MCA territories on each hemisphere at three different levels; totally 18 ROIs in one patient) objectively and automatically by NUEROFLEXER (Nihon Medi-Physics Co.,Ltd.). CVR was calculated as the increase rate of CBF after ACZ.

RESULTS

All ACZ challenge SPECT and DSC-MRI studies were successfully performed. The correlation coefficients of CVR between SPECT and DSC-MRI were R^2 = 0.223, (p<0.001) without the VOF rescaling and R^2 = 0.573 (p<0.001) with the VOF rescaling, respectively. The slope of regression line got close to 1, and y-intercept was neared to 0 with VOF rescaling. Note that the left figure is without the VOF rescaling, the right one is with the VOF rescaling.



DISCUSSION

We consider that the VOF rescaling scheme effectively minimizes the AIF-induced variance between two DSC-MRI data. The CVR value obtained by ACZ challenge DSC-MRI with the VOF rescaling is well correlated with ACZ challenge SPECT. ACZ challenge DSC-MRI is considered as an alternative technique to evaluate cerebral hemodynamics.

CONCLUSION

DSC-MRI can be performed in conjunction with clinical routine MRI examination including MRA, thus anatomical information and cerebral hemodynamics can be obtained in one study without radiation exposure.

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