Evaluation of tracer kinetics parameters in brain gliomas using combined T1W and T2*W contrast-enhanced dynamic MR imaging: comparison with pathological findings

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Purpose

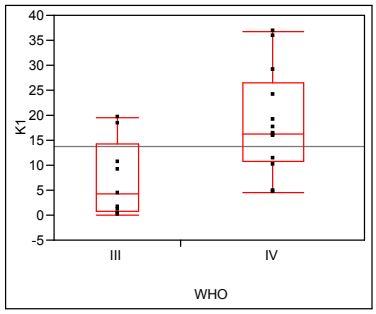
To use dynamic contrast material-enhanced MR imaging and a distributed-parameter kinetics model for evaluating the vascular characteristics of brain gliomas. We evaluated various tracer kinetics parameters of brain gliomas using combined dynamic contrast enhanced MR imaging (T1W dynamic contrast MRI; DCE-MRI) and dynamic susceptibility contrast MR imaging (T2*W dynamic susceptibility contrast MRI; DSC-MRI) in one examination. These parameters were compared with WHO histological grade, MIB-1 labeling index and microvessel density (MVD) evaluated by CD34 immunoreactive vessels.

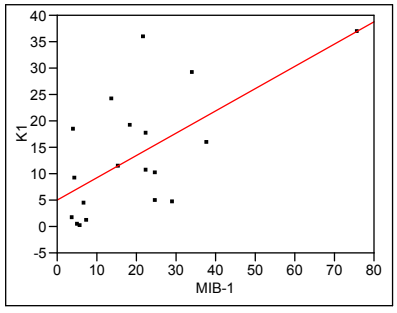
Methods and Materials

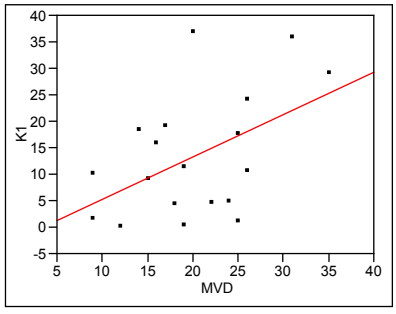
Twenty-three patients with surgical proven brain gliomas (23-75y.o., 9 male 14 female, WHO grade III: 10 patients, grade IV: 13 patients) were examined on 3T MRI. The DCE-MRI was acquired with 3D T1-FFE (TR/TE/FA=2.1/ 0.93/20). 12 slices were obtained during 90 seconds at 2.2 seconds time resolution. Following the DCE-MRI, the DSC-MRI was acquired with 2D-GEEPI (1200/20/70). 12-20 slices were obtained during 72 seconds at 1.2 seconds time resolution. A 7.5mL of Gd contrast medium were injected at a speed of 3.0mL/sec followed by 20mL injection of saline on each dynamic study. Totally 15mL contrast medium was used in this study. All data were transferred to post-processed PC. DCE-MRI data were processed using in-house developed software, and various parameters [tissue blood flow (F), K1 (transfer constant) and PS (permeability-surface area product)] were calculated with the tissue homogeneity model. From the DSC-MRI data, we calculated rCBV value through standard deconvolution algorithm on single value decomposition. DCE-MRI data was obtained form 22 patients; DSC-MRI data was obtained from all 23 patients. Pathological WHO grade was recorded from post-operative pathological report. MIB-1 and MVD were counted by neuropathologist in 20 patients. These tracer kinetics parameters were compared with pathological findings (WHO grade, MIB-1 and MVD). Statistical analyses were performed by Wilcoxon rank-sum test and regression analysis.

Results

Our results showed significant differences between WHO tumor grades (III vs IV) in all parameters [F ($p < 0.01$), K1 ($p < 0.05$), PS ($p < 0.05$) and rCBV ($p < 0.05$), respectively]. There were significant correlation between MIB-1 and K1 ($r = 0.630$, $P < 0.01$), MVD and F ($r = 0.461$, $P < 0.05$), MVD and K1 ($r = 0.486$, $P < 0.05$), MVD and PS ($r = 0.507$, $P < 0.05$), respectively. The rCBV value was not correlated with MIB-1 and MVD.







Discussion

The tracer kinetics parameters are high in grade IV gliomas; especially the K1 value has a significant correlation with MIB-1 and MVD. These parameters should be correlated with the tumor vascularity and/or tissue permeability, and will provide additional information for diagnosis and prediction prognosis.

Our protocol, which can derive the various tracer kinetics parameters of brain tumors in one examination, will be a promising protocol to evaluate the characteristics of brain tumors in a clinical setting.

References

Buckley DL, Roberts C, Parker GJ et al. *Radiology* 233: 2004