

Effects of the Intravenous Contrast Agent of GD-DTPA on Time Dependent DTI on Patients with Brain Tumors

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Introduction

Diffusion tensor MR imaging (DT-MRI) is sensitive to the preferential diffusion of water molecules along axonal fibers, a property called anisotropic diffusion (1,2) and is helpful to identify different tumor components and to differentiate tumor invasions from normal brain tissues or peritumoral edema (2). In routine clinical neuroimaging, MRI for brain tumors should be performed with injection of a contrast material to identify tumor margins and to improve identifications of tumor characteristics. The contrast material could be leaked into the extra-vascular space if a blood-brain barrier (BBB) is broken down. When DT-MRI is included in a tumor study, it is usually performed before the contrast administration. However, DT-MRI after the contrast administration followed by routine MRI may be necessary in certain circumstances. Some validation studies should be necessary before applying clinical studies. Previous studies with a contrast agent were only performed with DWI on mixed physiological conditions (3, 4, 5). However, there is no validation study applied only on brain tumor. In addition, the effect of contrast materials on DT-MRI or the diffusion anisotropy has not been examined. Our aim in this preliminary study, therefore, was to investigate the possibility of acquiring DT-MRI data after intravenous administrations of contrast materials on patients with brain tumors.

Materials and Methods

To investigate time-related effects of the intravenous contrast agent of GD-DTPA, we acquired DTI data five times. Two DTI scans were acquired before injections of the agent (pre1, pre2). One DTI scan was performed with injections of the contrast agent(during3). Finally, additional two DTI scans were acquired right after the previous scan(post4, post5). Fourteen patients of 8 metastases and 6 glioma were enrolled in this study. MR imaging was performed at a 3T clinical scanner (Philips, Achieva, Best, The Netherlands). Each DTI data set was acquired by using a single-shot spin-echo echo-planar imaging (EPI) sequence with two *b* values of 0 and 800 s/mm² and 6 diffusion-encoding directions. The diffusion tensor maps were calculated on a voxel-by-voxel basis with the DTIStudio program (<http://www.mristudio.org>). DT-MRI data in patients with brain tumors were evaluated using defining regions of interest (ROIs) that were placed at the tumor region on the enhanced lesion, at the peritumoral edema on the surrounding T2 hyper-intensity lesion, and at the contra-lateral normal-appearing brain tissue. The means and standard deviations for each subject were obtained from each DT-MRI indexes of FA and Trace and DT-MRI raw data of mean B0 and mean DWI (*b*=800) over six diffusion-encoding directions. The Kruskal-Wallis rank sum nonparametric ANOVA test was performed to find effects of three ROIs and the contrast media. If we found any statistical significance, then the Wilcoxon signed-rank test was performed for the post hoc test. *P* < 0.05 was accepted as the minimum level of significance.

Results

Figure 1 shows the representative DTI maps before (Fig 1a) and after (Fig 1b) the injection of contrast media. To validate the technical stability of DTI acquisitions, we tested the repeatability of DTI maps. There are no statistically significant differences between pre1 and pre2 for both FA and Trace maps. In addition, there are also no statistically significant differences between post4 and post5 for both FA and Trace maps. Therefore, we averaged ROI data of two pre-enhanced FA or Trace maps and called “pre” and ROI data of two post-enhanced FA or Trace maps and called “post”. Therefore, we used three ROI data of pre, during, and post in the following analyses. There are significant differences between “pre” and “during” in ROIs of edema and tumor lesions for both Trace and FA. In addition, there are significant differences between “during” and “post” in ROIs of edema and tumor lesions for Trace, but not for FA.

Discussions

There are significant differences of DTI indexes (Trace, FA) between pre or post and during contrast-enhanced of DTI indexes (*P*<0.049), except the tumor area of Trace on pre- and post-contrast enhanced DTI (*P*=0.268). Although there is some controversy, our results are supported by previous studies of DWI with contrast administrations by Firat et al.(6) and Yamada et al.(3). It is suggested that not only diffusion anisotropy, but also diffusion isotropy may be changed after intravenous injections of gadolinium-based contrast agent in patients with brain tumors. There is also the significant ROI effects in Trace and FA (*p* <0.001). This result is consistent with those of the previous DTI-based tumor imaging studies (7,8).

Conclusion

DT-MRI which is obtained during or at a time of at least 2 minutes 30 seconds after contrast agent injections may be shown signal alterations in the malignant brain tumors. Our data about the first evaluation for the effects of contrast media and scan time to DT-MRI can be a useful basis to the further DT-MRI study with the contrast agent injection.

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Fig. 1 A case obtained from 54 year old female taken 48 hours after the symptom is onset.

