

Dynamic Contrast Enhanced MRI (DCE-MRI) of Multiple-lesions in One-Time Injection Using Wideband technique

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Abstract

Through implementing Wideband MRI technique onto Dynamic contrast enhanced (DCE) sequences and administrating intravenous contrast agents, we could monitor the perfusion of multiple concerned regions simultaneously and access vascular characteristics. This method is especially suitable for using as an evaluation tool of metastatic case and multi-organs at the same time.

Introduction

Dynamic contrast enhancement technique is to apply a series of repeated high speed scans (10~20sec per scan) over a specific region of interest along with contrast agent administration in order to observe the state of functional microcirculation [1]. In prior DCE methods, the high speed scans poses a demand onto the imaging system and the number of slices in the imaging package was strictly limited by hardware performance, resulting in a narrow coverage.

Wideband MRI is able to acquire information of multiple sites simultaneously by increasing the acquisition bandwidth [2]. Through applying this technique, the number of slices can be easily doubled without challenging the hardware. Moreover, the added slice packages can be placed away from the first site thus researchers could monitor more than one lesions in real-time. In this study, two imaging packages were performed simultaneously to monitor perfusion of mice kidney and tumor in the hind limb.

Materials and Methods

Animal preparation

Male, 6-week-old, Nod-SCID mice were used. 1×10^6 cells of non-small cell lung cancer cell line CL1-0 transfected VEGF isoform 189 were injected intramuscularly into the right hind limb. MR scans of the mice were performed after one week of the implantation.

Dynamic contrast enhancement of Wideband MRI

The images were acquired by a 7T MRI scanner (Biospec, Bruker, Germany). Gradient echo (FLASH) was used and the parameters are listed as follow: TR 200 ms, TE 3.628 ms, flip angle 40° , NEX=1, 15 slices for each imaging package, slice thickness=0.6mm, inter-slice distance=1mm, matrix size 256 x 128. Scan time of a single repetition is 25.4s with a total of 33 repetitions, contrast medium injected on the fifth repetition. DCE MRI images were analyzed using Tofts model to acquire perfusion constants such as K^{trans} (the volume transfer constant). In Wideband technique, the number of images acquired simultaneously is determined by a "W factor", e.g. number of locations monitored simultaneously. We used $W=2$ in our experiment, making the image slices doubled (a total of 30 slices shown in Fig. (a)).

Results and Discussions

Figure (b) shows the kinetic change of two regions that were monitored simultaneously. According to Figure (c) the signal intensity of kidney was elevated after contrast agent injection, and followed by a sudden descent due to inverse effect of excessive amount of contrast medium accumulated. As for the limb tumor, it was positive enhanced throughout the whole experiment. The K^{trans} map was derived from the DCE MRI using Tofts model (Figure (d)).

Conclusions

With the use of Wideband MRI, a 2-location DCE MR studies of kidney and tumor mass was performed successfully. The different perfusion characters of kidney and tumor can be obtained at the same time. The results show that Wideband MRI is highly feasible to acquire tumor vascular constants with multi-locative lesions in one-time injection, which might become a potent evaluative tool of treatment response for primary tumor and its distant metastasis.

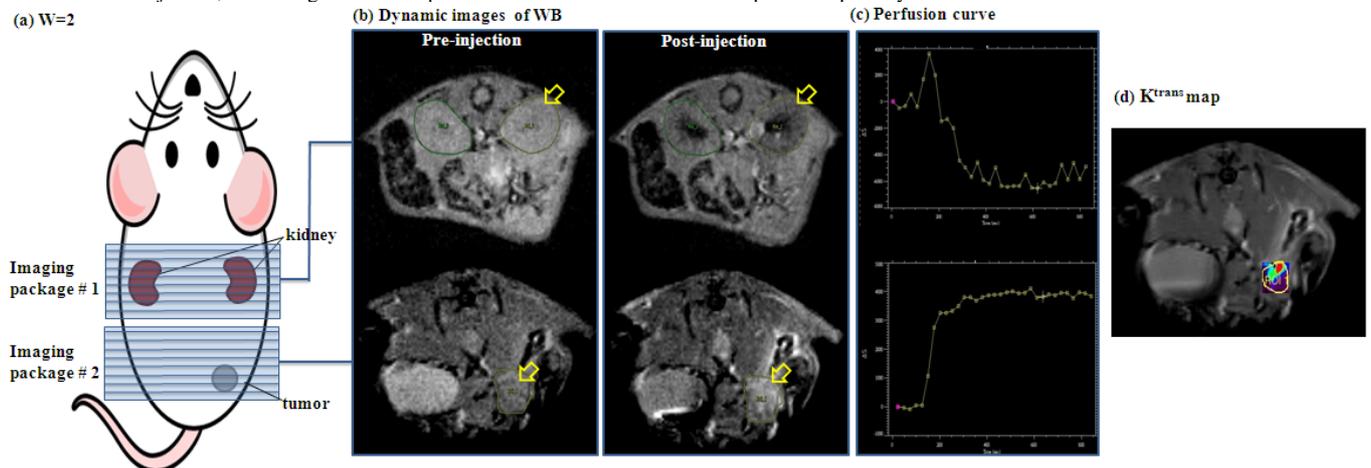


Figure. Imaging results of a 2-location DCE study. (a) The two regions that were monitored simultaneously (image package #1 & #2). (b) Wideband DCE images, the upper image show the kidneys while the lower image is the intramuscular limb tumor. (c) Perfusion curve of kidney and intramuscular limb tumor after contrast medium administration. In previous DCE methods, the MRI hardware limits the scanning to only one region. (d) K^{trans} map of intramuscular limb tumor.

References

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