

# Magnetic Resonance Thermometry of Rat Using Wideband technique

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## Abstract

The purpose of this study was to apply Wideband MRI technique to Magnetic Resonance Thermometry (MRT) study. This implementation allows us to monitor the local temperature change or temperature gradient alone tissue in different anatomic locations simultaneously, therefore, we can obtain the information faster than traditional gradient echo phase mapping.

## Introduction

Wideband MRI is a new technique capable of acquiring information of multiple sites simultaneously by increasing the acquisition bandwidth<sup>[1]</sup>, the number of acquired slices can be multiplied and acquisition time of each slice can be reduced without challenging the hardware. Each slice package can be placed far apart from each other without anatomic continuity. This approach enables the monitor of temperature distribution with high temporal resolution by accelerating each frame.

This approach enables simultaneously monitoring more different anatomic locations or organs in one single acquisition. MR thermometry provides important information of thermotherapy with repeated high-speed scans. Thus, the kinetic characteristics of a specific organ or lesion can be assessed by obtaining time-series phase map. Specific pharmacokinetic models are then applied to describe functional microcirculation and tumor angiogenesis<sup>[2]</sup>. There is limitation of MR thermometry to detect the dynamic temperature change in thermotherapy without sacrifice the spatial resolution. In addition, long scanning time might lose kinetic information. To maintain the same spatial resolution within reasonable short acquisition time, the implementation of Wideband MR technology in MR thermometry study provides a solution not only to increase the scanning speed but also to obtain dynamic information of fast changed body temperature during thermotherapy. In this study, we implemented Wideband MR Technology into MR thermometry study in a rat model to evaluate the local temperature change.

## Materials and Methods

### Animal preparation

Male, 6-week-old, normal SD rat were used.

### Wideband DCE MRI

The images were acquired by using a 7T MRI scanner (Biospec, Bruker, Germany). Gradient echo(FLASH) was used and the parameters are listed as follow: TR 150 ms, TE 5 ms, flip angle 15°, NEX=10, 10 slices for each imaging package, slice thickness=1mm, inter-slice distance=1mm, matrix size 256 x 192. Scan time of a single repetition is 4min in traditional gradient echo and 2min in gradient echo with wideband. The room temperature was 18 °C and rat body temperature was 29.8°C after 1 hours waiting to reach thermo-equilibrium with environment and measured by anus thermocouple, then we acquired a traditional and wideband image as a temperature reference image. The heating system was made by tycoon tube connect to warm water circulation and set to 60°C and wait for 30 min, then acquired a traditional and wideband image again as temperature control image. In Wideband MR technique, the speed of images acquiring is determined by a “W factor”, a W=2 was used in our experiment which made the scan speed doubled.

## Results and Discussions

Figure (a) shows the local body temperature change of traditional gradient echo, figure (b) shows the local body temperature change of gradient echo with wideband. Two methods both show body temperature was increased at the back region.

## Conclusions

With the use of Wideband MRI, higher temporal resolution could be reached, thermotherapies in tumors like high intensity focused ultrasound (HIFU) or nano-gold particle with optical heating systems, which produce local body temperature changes could be monitored with high temporal resolution without sacrifice spatial resolution to assume the heated region and avoid damage of normal tissues.

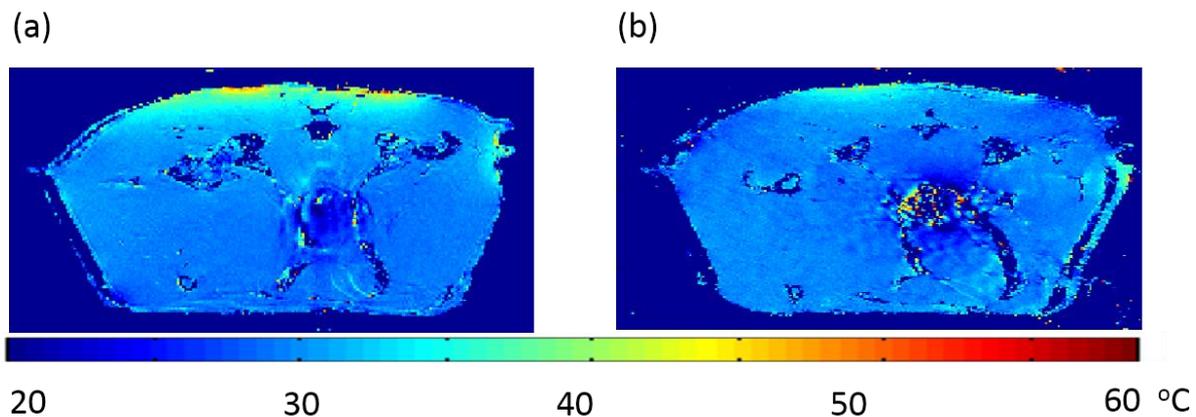


Figure. Imaging results of a two-location DCE study using Wideband MRI technique. (a) The two regions that are monitored simultaneously (image package #1 & #2). (b) Wideband DCE images, the upper image shows the kidneys while the lower image is the tumor implanted within muscle of the hind limb. (c) Signal-time curves of kidney parenchyma and implanted tumor in the hind limb are obtained.

## References

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