Simultaneous High-Resolution Imaging of Mouse Knee and Ankle at 3.0T Using a Specially Designed Dual Array Coil

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Introduction

Longitudinal studies of small animals can be useful for evaluating repair responses following therapeutic treatment of arthritis. In vivo monitoring of the same animal over time decreases data variability from different animals, and reduces the number of animals needed. Using a dedicated RF coil that we developed for mouse knee imaging, we have successfully conducted longitudinal studies of inflammatory arthritis on mouse knees using high-resolution MRI [1,2]. Since the field of view used is much larger than the knee joint, it allows for evaluation of the extra-articular manifestations of arthritis and development of multi-organ models of the disease. Therefore, we designed and built a new dual array RF coil for simultaneous imaging of the mouse knee and ankle, and tested its performance on normal wild-type mice and transgenic mice with inflammatory arthritis.

Methods

The study was conducted on a Siemens TRIO whole body 3.0T MRI scanner after approval from the Institutional Animal Care and Use Committee of our institution. A dedicated RF coil was designed and constructed for imaging adult mouse knee and ankle simultaneously (Fig. 1). The coil consists of two circular coil elements – a 1.5 cm diameter element for imaging the knee and a 1.2 cm diameter element for the ankle. Each element is made up of two parallel gauge-14 copper wires. The separation of the two elements is 1.8 cm. To eliminate inductive coupling between the two elements, underneath the coil each element has a small extension that partially overlap with that of the other element. During scans, the mouse leg was inserted through the coil as shown in figure 1. Three-dimensional FLASH sequence was used to obtain fat suppressed T1-weighted images with TR 45ms, TE 9.03ms, flip angle 25^0, FOV 28mm x 28mm, 256x256 pixels, slice thickness 0.16mm, signal averaging 1, and scan time 9:32 minutes. The spatial resolution is 109x109x160 microns. Adult wild-type mice and transgenic mice with inflammatory arthritis were imaged. GdDTPA:PBS contrast enhanced scans were performed.

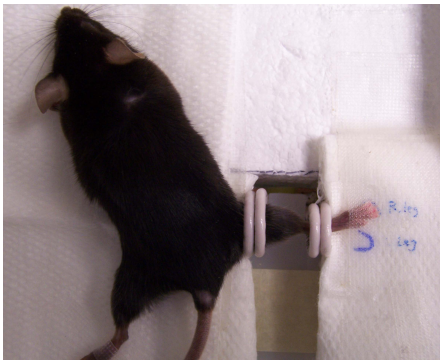
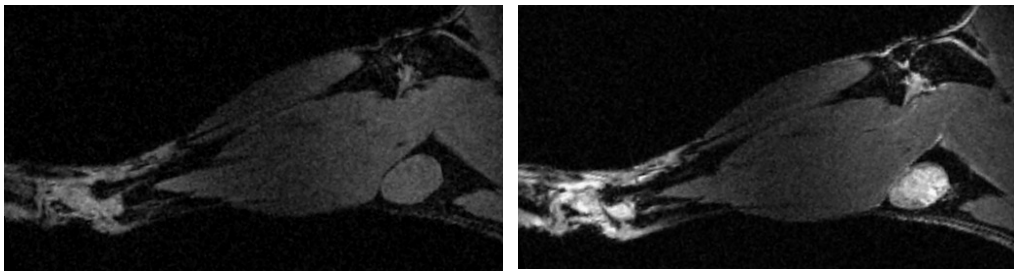


Figure 1. Photo of the RF coil setup with an anesthetized mouse.

Results



2a 2b

Figure 2. Pre-contrast (a) and post-contrast (b) images of the knee and ankle of a transgenic mouse. Images show inflamed popliteal lymph node with ankle swelling, but minimal knee inflammation.

Discussion & Conclusion

The dual array coil for imaging mouse knee and ankle provides similar signal-to-noise ratio (SNR) and image resolution as our previous coil for imaging the mouse knee alone. Since this coil covers only the joint regions needed to be imaged, the total effective coil volume is minimized resulting in high SNR to support high-resolution imaging. Our preliminary data on transgenic mice show that this dual coil can provide information potentially useful for the development of multi-organ model that cannot be obtained from imaging a single joint. An example is illustrated in figure 2. This coil design may be extended and modified for use in simultaneous imaging of two mice to increase scanning throughput. This coil should be useful for longitudinal mouse studies of arthritic diseases, and may also be applied to study other diseases.

Reference

1. Proulx ST, et al. Ann N Y Acad Sci. 2007.
2. Proulx ST, et al. Arthritis & Rheumatism. In Press.