Design of a 1H/31P Surface Coil for *in vivo* Spectroscopy and Imaging of Skeletal Muscle in the Mouse Leg at 11.75 T

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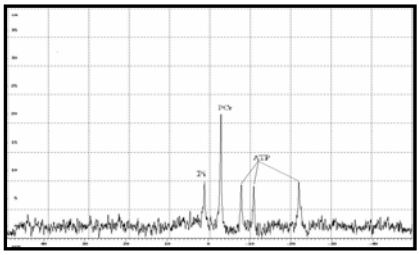
Introduction

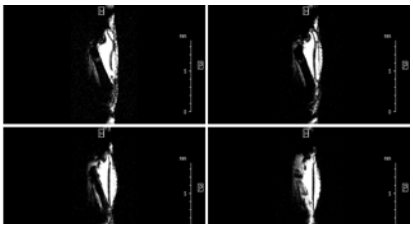
Magnetic Resonance techniques are extremely useful in the analysis of skeletal muscle tissue. In particular, the quantification of proton (1H) and phosphorous (31P) metabolites by MR spectroscopy in intact and *in vivo* muscle provides important data about muscle energetics and metabolic state (1). Surface coils are widely used in MRI, as they offer high localized signal-to-noise ratios (SNR) (2). In this work, we present a switchable Radio Frequency (RF) coil tuned to 1H and 31P for operation on a vertical 11.75-T microimaging system. This surface coil has been optimized to investigate skeletal muscles in the leg of the adult mouse through both 1H and 31P MR microscopy and spectroscopy.

Experimental

The surface coil was built using a simple balanced L-type matching network so that it could (a) be tuned to both 1H and 31P frequencies (500 and 202.4 MHz, respectively) and (b) span the soleus muscle of the C57 mouse leg. The coil was imaged at 11.75 T using small phantoms that are on the order of the leg size (85% phosphoric acid in 2-mL vials) to assess the FOV of the coil for both nuclei. Using the NHFML-supported 500-MHz magnet at the FAMU-FSU College of Engineering, spin-echo (SE) and gradient-recalled echo (GRE) sequences were used to acquire these images. Also, 1H and 31P images and spectra were acquired.



^{31}P spectrum of PCr-ATP solution at 11.75 T



^{1}H GRE images of the excised mouse leg

Results and Discussion

A 1H/31P surface coil with apparatus to maintain the animal was successfully designed and tested at 11.75 T. It was tuned successfully at both resonance frequencies (500 MHz and 202.4 MHz). The final coil had a length of 10 mm and width of 3 mm. Spectral linewidths of 45 Hz for 1H and 20 Hz for 31P indicate the utility of this design for interrogating muscle metabolites. The SNR of these spectra were 20,000 and 125 for 1H and 31P, respectively. As an indicator of the coil FOV for spectroscopy, 1H GRE images (TE/TR = 5/1000) and 31P GRE images (TE/TR = 3/1000 ms) were acquired, demonstrating a penetration distance of 4.0 mm for 1H and 3.4 mm for 31P. The surface coil was used to acquire 1H images (TE/TR = 5/3000 ms) of excised mouse leg.

Conclusions

These images show the feasibility of using this surface coil for *in vivo* imaging of the soleus skeletal muscle; in addition, the over-tipped images display the mouse femur and other anatomical landmarks. Using nonlocalized spectroscopy and MR microscopy, this coil will be utilized to examine metabolic changes in 1H and 31P spectra and images of *in vivo* soleus muscle of the adult mouse to model diffusion-rate reactions under hypoxic stress.

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References

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