Magnetic Resonance Imaging of PLA-PEG Drug Delivery Systems

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Introduction

We have recently developed a promising organic polymeric tag (polyethylene glycol, (PEG)) to detect molecules using magnetic resonance imaging (MRI). PEG is known to be a biocompatible, non-immunogenic, non-antigenic, water-soluble molecule that can increase blood circulation times and enhance proteolytic resistance.[1] We take advantage of these well know properties and use NMR techniques to remove background ^{1}H resonances, theoretically leaving only signal from the PEG tag. To demonstrate in vivo imaging capabilities, we plan to visualize biodistribution of a drug delivery vehicle in rat models. One such promising system, poly-D,L-lactide-poly(ethylene glycol) (PLA-PEG), forms micellar structures allowing hydrophobic drugs to be encapsulated within its interior. While thus shielding toxic drugs from normal tissue, release of the drug payload is instigated by progressive breakdown of ester bonds within the PLA-PEG micelle. Selective delivery can be accomplished by targeting molecules tethered to the ends of the PEG chains. In addition to its importance as a drug delivery vehicle, PLA-PEG micelles naturally contain a rich source of PEG. Thus, we can easily track the localization of PLA-PEG micelles without altering the biodistribution of this drug delivery system.

Experimental

Radiofrequency (RF) coils (^{1}H/^{1}H surface coil and a ^{1}H/^{13}C volume coil) were built at the AMRIS facility (UF). MRI experiments were conducted on an Agilent Magnex Scientific 11.1 T 40 cm horizontal magnet, also at the AMRIS facility (UF), using the above custom built RF coils.

Results and Discussion

Appropriate radiofrequency coils need to be built to assess PLA-PEG localization in the liver and clearance from the blood stream using MR spectroscopy. A surface coil will be used excite and detect PEG signal in the liver, while a volume coil placed at the base of the rat tail will be employed to hone in on PEG signal from the vasculature. We have constructed a ^{1}H/^{1}H butterfly transceive surface coil (Fig. 1) that has been used to mainly image the liver in a rat (Fig. 2). Similarly, we have built a ^{1}H/^{13}C transceive volume coil (Fig. 3) that was able to generate images of a cylindrical phantom (Fig. 4). As both coils are prototypes, final versions of the coils are being built, after which we will commence tracking of the drug delivery system in rats following intravenous injection.

Fig.1 A custom built ^{1}H/^{1}H butterfly surface coil tunable to a frequency of 474 MHz (11.1 T).

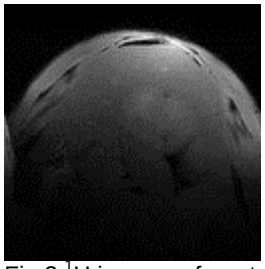

Fig.2 ^{1}H images of a rat abdomen, mainly capturing the liver, acquired using the surface coil in Fig. 1.

Fig.3 A custom built ^{1}H/^{13}C saddle coil for an 11.1 T MRI scanner.

Fig. 4 ^{1}H image of a 10 mM PEG aqueous phantom, acquired using the coil in Fig. 3.

Conclusions

Thus far, prototypes of radiofrequency coils have been constructed to image PEG in animals. The next phase of research will involve building the final coils, followed by imaging of the drug delivery system.

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References

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