One-Shot Measurement of Spin-Lattice Relaxation Times in the Off-Resonance Rotating Frame of Reference with Application to Breast

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Off-resonance spin locking makes use of the novel relaxation time T1rho-off, which may be useful in characterizing breast disease. Knowledge of T1rho-off is essential for optimization of spin-locking imaging methods. The purpose of this work was to develop an optimal imaging technique for in vivo measurement of T1rho-off. Measurement of T1rho-off using conventional methods requires long exam times which are not suitable for patients. Exam time may be shortened by utilizing a one-shot method developed by Look and Locker, making in vivo measurements possible. The imaging method consisted of a 180 degree inversion pulse followed by a series of small-angle alpha pulses to tip a portion of the longitudinal magnetization into the transverse plane for readout. During each relaxation interval (between alpha pulses), a spin-locking pulse was applied off-resonance to achieve T1rho-off relaxation. The value of T1rho-off was then determined using a three-parameter non-linear least-squares fitting procedure. Values of T1roff were measured for normal and pathologic breast tissues at several resonant offsets. These measurements revealed that image contrast can be manipulated by altering the resonant offset of the spin-locking pulse. Whereas T1 relaxation times were nearly identical for normal and cancerous tissues, T1rho-off relaxation times differed significantly. These results may be useful in improving image contrast in magnetic resonance imaging.