

Interventional MRI Hardware and Functional Imaging Techniques for Detection and Staging of Cancer

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Abstract

Despite increased awareness, approximately 1 in 8 women will develop breast cancer in their lifetime. Early detection of breast cancer greatly increases the patient survival rate (5-year at 98% when stage is confined at diagnosis). The ability of MRI to resolve small (< 1 cm) lesions and provide high soft tissue contrast allows earlier detection and diagnosis than with ultrasound. Therefore, MRI is rapidly growing as a tool for image-guided procedures in the breast such as needle localizations, biopsy, and ablative therapies. The inefficiencies of the current procedures limit the widespread use of MRI for image-guided breast interventions. To improve efficiency for MRI-guided breast cancer procedures, this work presents a novel RF solenoid coil and system for localizing breast lesions with 360 degree access to breast tissue. This development enables in-bore robotic procedures under real-time MR guidance.

In addition to using MRI as a guidance tool for cancer interventional procedures, MRI can also be used non-invasively to acquire functional information related to cancer progression. Hyperpolarized ^{13}C -pyruvate MRI is a technique to investigate metabolic information in-vivo, but quantitative measurement of metabolic rates is challenging. This work presents a new technique to improve the confidence of dynamic hyperpolarized ^{13}C kinetic modeling to measure intracellular metabolic information. Simulations are also presented that reveal optimal acquisition parameters for dynamic imaging to achieve accurate kinetic modeling, focusing on the required image SNR. Preliminary data in animal models will demonstrate feasibility of a combined approach using Gd-based perfusion in conjunction with hyperpolarized ^{13}C -pyruvate MRI.