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Multi-parametric MR Approach in Breast Cancer Research

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Detection, localization and staging of breast cancer are challenging using mammography and ultrasound. Hence alternate methods of diagnosis like evaluation of the role of various MR methodologies have been the focus in recent years. In the last two decades our group carried out multi-parametric MR approach and its utility in a large cohort of breast cancer patients. In addition to routine T1 and T2 −weighted imaging, dynamic contrast imaging was found to be useful in distinguishing benign versus the malignant breast tissues and for determination of various kinetic parameters. Additionally, the apparent diffusion coefficient (ADC) values determined using diffusion MRI (DWI) was found to be a valuable biomarker for discrimination of normal, benign and malignant breast tissues. Also, longitudinal investigation of breast cancer patients receiving neoadjuvant chemotherapy using DWI showed that the mean ADC prior to therapy of malignant breast tissue was statistically lower and the value gradually increased during the course of therapy.

Further, we also used in vivo localized proton MRS as an adjunct to MRI and DWI as an additional diagnostic tool. Normal breast tissues was dominated by a huge lipid peak with little contribution from water (low water-to-fat (W-F) ratio); while malignant breast tissues contain more water content (high W-F ratio). Suppression of water and fat peaks showed detection of choline containing compounds (tCho) in malignant breast tissues. Additionally it was possible to carry out in vivo quantitative estimate of the concentration of tCho using water as an internal reference. We also evaluated the association of ER, PR and HER2/neu status of breast cancer patients with tCho concentration. Non-triple negative and triple positive patients had a significantly higher tCho concentration compared to triple negative patients, indicating complex molecular mechanism of cell proliferation and the molecular heterogeneity of breast lesions. In patients receiving therapy, our work indicated that both W-F ratio and tCho can be used as biomarkers for diagnosis and for monitoring the tumor response to therapy.

Recently, a multi-parametric approach (using routine MRI, DWI and MRS) based on tumor metabolic, diffusion and anatomical measurements for early identification of non-responders was carried out in breast cancer patients. Combination all three MR parameters (ADC, tCho and tumor volume) after third cycle of NACT yielded 100% specificity and PPV with 91.3% sensitivity. The 100% PPV after third cycle of NACT implies that there are no false positive cases and demonstrated the potential of multi-parametric approach as a better predictor of treatment response.

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