Potential of DW-MRI in Monitoring the Therapeutic Response in Breast Cancer Patients

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Introduction

Changes in water self diffusion is an early indication of the pathologic processes that tend to alter the cellular structural organization, by the destruction or regeneration of membranous elements or by a change in cellularity. This diffusion of water in tissues can be observed by diffusion weighted MR imaging (DW-MRI) and is quantified by apparent diffusion coefficient (ADC) which is analogous to self diffusion coefficient[1]. ADC is a representation of the translational motion of water arising from the combined affect of bulk flow, gross motion, and tissue perfusion. ADC depends largely on the barriers to diffusion of the water in its microenvironment like cell organization, cell density, microstructure and microcirculation, there by a correlation of tumor cellularity and ADC values. In combination with standard MR protocols, diffusion weighted imaging and ADC maps can assist in monitoring the tumor growth and its response to therapy earlier than changes in tumor size[2]. In this study the role of DWI in assessing the response of breast cancer to neoadjuvant chemotherapy is evaluated.

Methods

Clinically proven breast cancer patients (n=13) undergoing neoadjuvant chemotherapy were recruited for this study. Nine pre-therapy patients and four patients who received three cycles of chemotherapy (CAF), along with nine normal volunteers were included in the study. All studies were carried out on a 1.5T Sonata, Siemens MRI scanner with the patients positioned prone in a phased array double breast coil. Following the routine imaging of the breast in three planes, diffusion weighted images were obtained using a single shot echo planar imaging (EPI) sequence (TR = 3400-4800 ms, TE = 84-99 ms). Sensitizing diffusion gradients were applied in three directions simultaneously with b values of 0, 500 and 1000 s/mm^2 in all the subjects. Mean ADC values were calculated from the ADC map by selecting circular ROI with same area for all the measurements.

Results and Discussion

The mean ADC value of tumors (0.93 x 10^{-3} ± 0.83 mm^2/s) was significantly less (p = 3.7x10^{-8}) compared to normal tissue (1.77 x 10^{-3} ± 1.7 mm^2/s). The decrease in ADC in tumor can be correlated to an increase in cellularity and there by restricting the diffusion of water molecules. After three cycles of chemotherapy the ADC value of tumor was found to be increased (1.36 x 10^{-3} ± 0.86 mm^2/s) and was closer to that of the normal tissue (p = 8.5x10^{-4}), indicating the response of the tumor to chemotherapy. The increase in ADC value is due to cell damage caused by the therapeutic agents which increases the fractional volume of the interstitial space because of apoptic body formation and cell loss, causing an increase in the mobility of water. The study proved that DWI has the potential in assessing the response of breast cancer to neoadjuvant chemotherapy. This method can be used in a clinical setting for a reliable and quantitative assessment of the tumor response to therapy.

A **B**

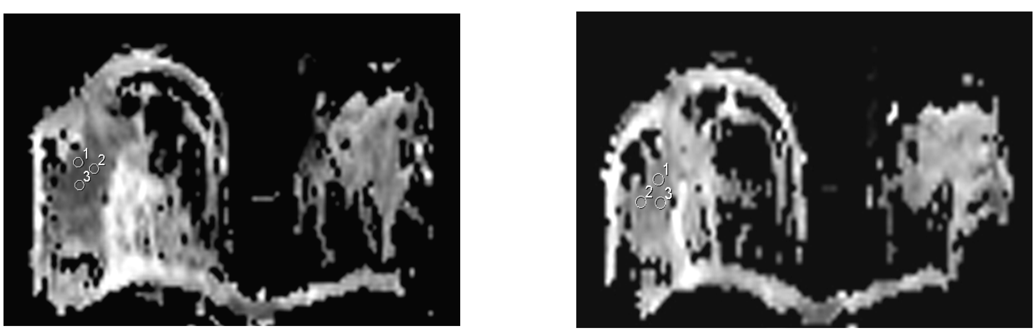

Figure1. ADC map of breast with ROI inside tumor. (a) Prior to chemotherapy. (b) Post chemotherapy.

References

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