Predicting the Response of Neo-adjuvant Chemotherapy in Locally Advanced Breast Cancer Patients by Diffusion Weighted Imaging

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Objective

In this study, the potential of apparent diffusion coefficient (ADC) obtained from diffusion weighted imaging (DWI) to predict the response of breast tumors to neo-adjuvant chemotherapy (NACT) and its relation to the change in tumor volume is evaluated.

Introduction

Monitoring the response of breast cancer to NACT is essential since it allows the clinician to measure the tumor resistance, to alter the dosage of the drugs used and to allow adequate time before surgery. At present, clinical assessment of tumor volume is often used in predicting the response of tumor to NACT. ADC values, a functional property of the tumor can be used quantitatively to assess the change in cellularity caused by anti cancer drugs. ADC values are known to exhibit an inverse relation with cellularity, which correlates the histological grade of the tumor[1].

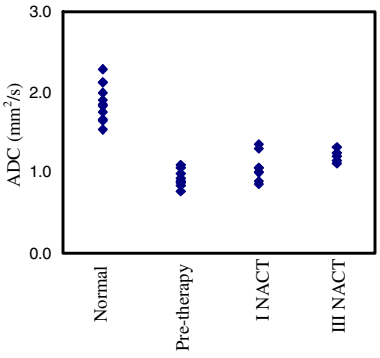
Materials and Method

Nine locally advanced breast cancer patients (mean age 47 ± 7 years) with T3 and T4 stages, scheduled for the full course of NACT were recruited for the study. MR studies were carried out on the same patient prior to therapy and after the first and third cycle of NACT at 1.5 T with the patient positioned prone on a double breast coil inside the scanner (Avanto/Sonata, Siemens). Twelve normal volunteers were also included in the study to obtain baseline data. DW images were obtained from both the breasts in transverse plane using an echo planar imaging sequence (EPI). Diffusion gradients were applied simultaneously in three directions with b = 0, 500 and 1000; TR = 5000 ms; TE= 87 ms; FOV = 250 - 350 mm; NS = 1-2; acquisition matrix = 128 x 128; and slice thickness = 5 mm. Mean ADC values were calculated from the ADC map by selecting circular ROIs of five pixels for all the measurements. Tumor volume was calculated from fat saturated T_2W images using the formula, Volume = ST (A_1+ A_2+ …. A_n), where ST is the slice thickness and A_n, the area of the n^{th} slice.

Results and Discussion

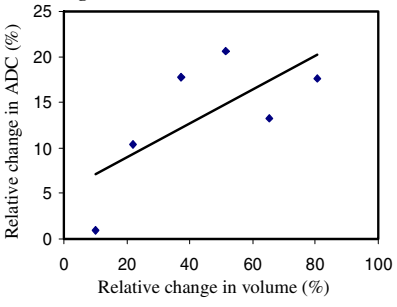
In untreated breast tumors, the ADC values obtained (0.94 ± 0.1 x 10^{-3} mm^2/s) were statistically lower than that obtained for the normal breast tissue of controls (1.88 ± 0.2 x 10^{-3} mm^2/s). ADC values of the tumor measured after first cycle of NACT in these patients (1.06 ± 0.16 x 10^{-3} mm^2/s) showed a significant increase compared to those observed prior to therapy as shown in Figure 1. Out of nine patients, five completed the full course of the therapy and there were three full responders while two were non responders. The three patients who showed complete response, the increase in ADC was greater than 40 % compared to the pre-therapy value, while in the two partial responders, the increase was less than 20 %.

Figure 1



Although, no significant correlation between the tumor volume and ADC values both prior to and post NACT could be observed, a significant correlation between the relative change in tumor volume and relative change in ADC values after first NACT was observed with r = 0.7 (Fig. 2) in six patients. The significant increase in ADC values after NACT is due to chemotherapy-induced apoptosis, which reduces the cellularity in tumors, there by increasing the extra cellular space for water diffusion in tumor. A measurable increase of chemotherapy induced apoptosis has been reported in human breast cancer due to NACT[2]. Early response of the tumor to therapy has been recently reported using MR spectroscopy after twenty fours hours[3].

Figure 2



Conclusion

Our present study demonstrates the potential of ADC in predicting the tumor response and the relation between tumor volume and ADC values.

References

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2. Rajan R et al., Cancer 2004; 100(7):1365-73.
3. Meisamy S et al., Radiology 2004; 233(2):424-31.