

The relation of apparent diffusion coefficient (ADC) measurements in normal glandular breast tissue to menstrual cycle and menopausal state at 3.0T diffusion-weighted imaging.

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INTRODUCTION:

The role of diffusion-weighted imaging (DWI) in the diagnosis and management of breast tumours is being explored¹. Hormone fluctuations during the menstrual cycle have potential to influence diffusion-weighted contrast because they cause changes on magnetic resonance imaging (MRI) such as increased water content and hence T1 during the second half, or secretory phase of the menstrual cycle^{2,3}. The increase in stromal oedema and vascular dilatation in the breast peaks just prior to menstruation. ADC values derived from DWI which are sensitive to changes in cell density, composition and volume of the extracellular matrix as well as membrane integrity are likely to be higher during the secretory phase, and potentially have greater variability. These influences are absent in the postmenopausal breast, but ADC values have not been documented with menstrual phase and menopausal status. This study demonstrates the effect of menstrual cycle and menopausal status on ADC measurements and establishes ADC values in normal glandular breast parenchyma at 3.0T.

METHODS:

13 healthy female volunteers (age 29-63, mean 40.6 years) were enrolled prospectively into this ethically-reviewed study by providing written informed consent. Each volunteer was scanned twice with an interval of 14-18 days (mean 14.6 days) using a bilateral 7 channel breast coil on a 3.0T Philips Achieva MRI scanner (Best, Netherlands). The day of their menstrual cycle was documented in relation to the scan date and scans classified into either proliferative (days 1-14) or secretory (days 15-28) phase. Menopausal status was recorded. Imaging used a diffusion-weighted single shot echoplanar sequence, with a SPAIR pulse combined with a slice-selection gradient reversal (SSGR) method for fat suppression. Sagittal sections were acquired from one breast with 7 b values (0, 100, 150, 200, 350, 700, 1200mm²/s) (TE 67 ms, TR 1220 ms, flip angle 90°, 18 mm field of view, 2.5 mm slice thickness with 0 slice gap, one excitation and a 92 x 89 mm acquisition matrix.) The ADC map was calculated from the source data using scanner software. The axial slice located at the level of the nipple was selected and measurements made by drawing a region of interest (ROI) of 200mm² in the most visually homogeneous breast parenchyma in the centre of the breast to minimise partial volume effects. Measurements were taken at the same locations within the breast for each subject at each time point. An independent t-test to assess the variation of ADC between pre- and postmenstrual volunteers and a one way ANOVA determined variation within different phases of the menstrual cycle. The mean coefficient of variation (CV)(standard deviation (SD)/mean) over the two time points was also calculated.

RESULTS:

There were 9 premenopausal and 4 postmenopausal women. One premenopausal volunteer was excluded from the analysis as she did not have a regular cycle and it was impossible to determine which phase of the cycle she was in. The mean ADC ($\times 10^{-3}$ mm²/s) of the proliferative phase was 1.8 ± 0.27 , the secretory phase was 1.87 ± 0.34 , and postmenopausal was 1.5 ± 0.23 (figure 1). There was a significant difference between the mean ADC values of premenopausal and postmenopausal women ($p=0.004$). Images of two representative volunteers are illustrated in figure 2. There was also a significant difference between the phase of menstrual cycle and postmenopausal state ($p = 0.039$). There was no significant difference between the mean ADC values in the two phases of the menstrual cycle (>0.05). ADC values varied between -14% to 6% in premenopausal women, (CV of 14% over the menstrual cycle in our volunteers), and from -12% to 3% in postmenopausal women (CV of 17%) between the two scanning periods.

Figure 1: Box and Whisker plot showing the difference in ADC values between phase of menstrual cycle ($p=0.039$)

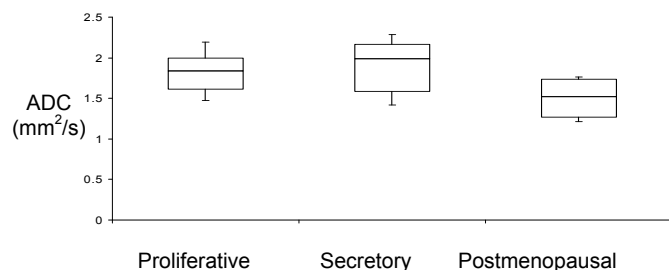
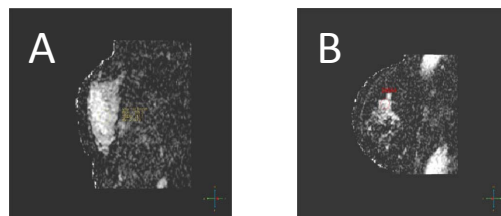


Figure 2: ADC maps with ROI for A) premenopausal breast, B) postmenopausal breast



DISCUSSION:

We have demonstrated significant differences in mean ADC values relating to menopausal state, with the ADC value being significantly higher in premenopausal volunteers in both menstrual cycle phases compared to postmenopausal volunteers. This is likely due to the effects of increased serum oestradiol and progesterone on the breast parenchyma and changes in breast density with age. Minor fluctuations in ADC of up to 5.5% have been reported previously⁴. Although there was a tendency for a higher ADC in the secretory phase, there was greater variability of the data at this time point. It is therefore preferable to perform repeat breast MRI studies in the first half of the menstrual cycle. In postmenopausal women the lower ADC of breast parenchyma may reduce DWI contrast for detecting tumours, limiting the utility in this group of women.

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