Differentiating breast lesions with hyper-intensity area on T2 weighted image: value of diffusion weighted imaging

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Purpose

Breast MRI is the most sensitive tool for detecting breast carcinoma, and it becomes inevitable tool for breast surgeon.[1] Differential diagnosis of breast lesion is confirmed by analysis of dynamic pattern and morphology of post contrast image.[2, 3] Some author reported the additional value of T2WI and diffusion weighted image.[4-9]

A lot of breast lesions show hyper-intensity on T2 weighted Magnetic Resonance Image, including fibroadenoma, cystic tumor, necrotic tumor, inflammation and so on. Among those, idiopathic granulomatous mastitis (IGM), also called as granulomatous lobular mastitis or granulomatous mastitis has a clinical and radiological findings similar to those of breast cancer. [10-13] IGM is a chronic inflammatory disease of unknown etiology. Galactorrhea, inflammation, breast mass, tumorous indurations, and ulcerations of the skin are the presenting symptoms. Even by dynamic contrast MRI, the findings of IGM and breast cancer overlap.[14]

Recently, application of diffusion weighted imaging (DWI) to the breast is advanced and DWI has potential of differentiating malignancy from benign condition without contrast material.[15, 16] We focused on the finding that inflammatory lesion sometimes has abscess component, that is, hyper-intensity on T2 weighted image (T2WI) and low apparent diffusion coefficient (ADC).[17] Also, breast cancer sometimes has hyper-intensity area on T2WI due to necrosis, extracellular matrix or cystic component, DWI may help differential diagnosis.

The purpose of our study is to evaluate the diagnostic performance of DWI for containing hyper-intensity area on T2WI.

Methods and Materials

Patient population

This study was approved by our institutional review board and informed consent was acquired by all subjects enrolled. We reviewed 1008 consecutive breast dynamic contrast breast MRI examinations from June 2008 to July 2010. First, we picked up 305 cases and inclusion criteria were as follows; 1) patients had not received presurgical systemic therapy 2) the diameter of the lesion is more than 1cm, 3) diagnosis is confirmed by histology or cytology, 4) signal intensity is equal to or lower than surrounding breast tissue on T1WI (exclude subacute hematoma).

Then we sorted into two group as follows; A) enhancing lesion with hyper-intensity area on T2WI (T2H) inside (78 cases), B) lesions without T2H (247 cases). We evaluated the ADC values of group A and we checked the pathological diagnosis of group A and B.
MRI Acquisition

MRI was performed on Trio Tim 3.0 Tesla Scanner or Avanto 1.5 Tesla Scanner (Siemens Medical Solutions, Erlangen, Germany) with 4 channel breast dedicated coil. Each examination include a T2-weighted turbo spin echo sequence, T1-weighted non fat suppressed sequence, T1 Weighted dynamic contrast MRI sequences with one unenhanced and four post-contrast scans, and DWI sequences. All series were performed in the axial orientation to enable full bilateral coverage with the minimum scanning time. The parameters of DWI sequences scanned by 3.0 T scanner were as follows; spin echo type single shot EPI sequence, TR=6,000ms, TE= 85ms, slice thickness=5mm, matrix 160x86, parallel imaging: none, fat sat with SPAIR, 32slices, acquisition time=2min 54sec, b values=0 and 1000. The parameters of DWI sequences scanned by 1.5 T scanner were as follows; spin echo type single shot EPI sequence, TR=5,900ms, TE= 76ms, slice thickness=5mm, matrix 160x86, parallel imaging: none, fat sat with SPAIR, slices, acquisition time=3 min, b values=0 and 1000.

Image Analysis

ADC was calculated automatically at scanning console from b values of 0 and 1000 sec/mm². All the images were transferred to Picture Archiving and Communication System (Centricity GE Healthcare, Milwaukee, USA). Region of interest (ROI) was chosen by a radiologist with ten years of experience in MRI (S.K.). ROIs were defined two points for each lesion over the corresponding region on the T2WI: 1) hyper-intensity on T2WI (T2H), 2) hypo or iso-intensity on T2WI (T2L).

Pathological Analysis

All the diagnosis is confirmed by histology or cytology diagnosed by pathologists with more than ten years of experience in breast pathology. Radiologic-pathologic correlation was made and we classified the cause of T2H to five categories, that is, cystic fluid, extracellular matrix, necrosis and abscess (including organized abscess).

Statistical Analysis

Kruskal Wallis test and post hoc Dunn's test were used to assess the distribution of ADC values of each pathological condition. The statistical software (SPSS version 18.0.1) was used for statistical analysis. P values less than 0.05 were considered statistically significant.

Results
Seventy eight lesions had T2H. But 23 lesions didn’t have T2L, so we excluded those cases to the evaluation of ADC at T2L. The diagnoses for these cases were malignant tumor (n=38), benign tumor (n=33) and inflammation (n=7). We present the typical cases of breast cancer (Fig 1) and IGM (Fig 2). The detail of the diagnosis was described at table 1. After the review of the pathology, hyper-intensity area on T2WI was due to intracystic fluid (n=16), necrosis (n=18), extracellular matrix (n=37) and abscess (n=7). There were two histologically proven inflammatory lesions without T2H among 1008 cases.

ADCs ($10^{-3}\text{mm}^2/\text{sec}$) at T2H were $0.80 +/- 0.26$ (standard deviation), $1.91 +/- 0.52$, and $1.75 +/- 0.34$ for inflammation, malignant tumor, and benign tumor respectively. (Fig 3) ADCs at T2L were $0.97 +/- 0.26$, $1.04 +/- 0.31$, and $1.41 +/- 0.19$ for inflammation, malignant tumor, and benign tumor, respectively. (Fig 4) ADCs of inflammation at T2H were significantly lower than that of malignant tumor ($p<0.001$) and benign tumor ($p<0.001$). And ADCs of benign tumor at T2L were significantly higher than that of malignant tumor ($p=0.024$) and inflammation ($p=0.012$).

One pitfall of differential diagnosis is subacute hematoma. (Fig.5) Hematoma sometimes develops after biopsy and shows hyper-intensity on T2WI and low ADC value. The key of differentiation is pre-contrast T1WI.

**Images for this section:**
**Fig. 1**: Figure 1. 42 year-old female with invasive ductal carcinoma of right breast. 1a. Axial T2WI of the same slice shows central hyper-intensity area with peripheral hypo-intensity area. 1b. Axial delayed phase post contrast enhanced image shows irregular shaped mass with oval shaped unenhanced area inside. 1c. Axial DWI (b=1,000) shows central hypo-intensity and peripheral hyper-intensity. 1d. ADCs of T2H and T2L were 1.72 and 0.68, respectively. 1e. High grade invasive ductal carcinoma was confirmed by mammotome biopsy. T2H was probably due to intra-tumoral necrosis.
Fig. 2: Figure 2. 38 year-old female with IGM of right breast 2a. Axial T2WI of the same slice shows oval hyper-intensity area and hypo-intensity area. 2b. Axial delayed phase post contrast enhanced image shows heterogeneous enhancing lesion with oval shaped unenhanced area inside. 2c. Axial DWI (b=1,000) shows hyper-intensity both T2H and T2L. 2d. ADCs of T2H and T2L were 0.76 and 0.95, respectively 2e. Hematoxilin Eosine stain of core needle biopsy specimen shows granulomatous inflammation with lymphocyte and neutrophil and There was no neoplastic condition. T2H was probably due to abscess.
Fig. 3: Figure 3. ADC values at the area of hyper-intensity on T2WI.
Fig. 4: Figure 4. ADC values at the area of hypo-intensity on T2WI.
**Fig. 5:** Figure 5. Post neoadjuvant chemotherapy of figure 1’s patient. 5a. Axial DWI (b=1,000) shows hyper-intensity. 5b. ADC map of the same slice. ADC of T2H was 0.54. 5c. Axial T2WI shows oval hyper-intensity area. 5d. Axial T1WI shows hyper-intensity. After chemotherapy, partial mastectomy was performed and hematoma was confirmed. In order to differentiate hematomata from inflammation, T1WI is useful.
Conclusion

We could differentiate inflammatory lesions from malignant or benign tumor by measuring ADC values of T2H. And measuring ADC at T2L, we could differentiate benign tumor from malignancy although there is some overlap between them.

References


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