# On Technical Essentials of 3.0 T MRI DWI Combined with DCE in Breast Cancer Examination

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**Abstract:** Objective: to discuss technical essentials of 3.0 T MRI (magnetic resonance imaging) DWI (diffusion-weighted imaging) combined with DCE (dynamic contrast enhancement) scanning in breast cancer examination. Method: 80 female patients who received MRI examination in our hospital from January 2015 to January 2018 were retrospectively analyzed. They were classified into breast cancer group (40 cases) and benign breast lesion group (40 cases) according to surgery and pathology or needle biopsy results. Breast 3.0 T MRI DWI combined with DCE scanning was conducted for both groups, and scanning and analysis results were recorded. Meanwhile, the image quality was evaluated. Results: there were 51 nidi in breast cancer group, and 50 nidi in benign breast lesion group. The comparison of enhancement method and TIC type of both groups $p<0.05$. DWI signal comparison of both groups $p>0.05$. ADC value at nidus side was much lower than that of normal tissues ($p<0.05$). All scanning images reached diagnosis requirements, from which the number, size, shape, bur, enhancement, blood supply, surrounding invasion and transfer of nidi could be known. The proportion of Class-A images was 91.25%; the proportion of Class-B images was 7.50%; the proportion of Class-C images was 1.25%. Conclusion: it is required to select the correct scanning sequence, utilize fat saturation technique and choose proper b value during DWI in breast cancer examination so as to improve imaging time resolution, reduce image artifact and ensure image quality.

**Keywords:** 3.0 T MRI; DWI; DCE scanning; breast cancer examination; technical essential

MRI is a kind of 3D imaging radiation-free non-traumatic examination with good soft tissue resolution, and with it, mammary tissue images can be gained from multiple layers and angles [1]. Breast MRI DWI combined with DCE scanning can improve diagnostic efficiency. In this study, technical essentials of 3.0 T MRI DWI combined with DCE in breast cancer examination were discussed to provide effective theoretical reference for clinical application.

## 1. Data and Method

### 1.1. General Data

80 female patients who received MRI examination in our hospital from January 2015 to January 2018 were retrospectively analyzed. Among them, 40 patients were diagnosed with breast cancer by surgery and pathology or needle biopsy. The age of breast cancer was 42-75, and the average age was $50.0 \pm 5.5$. The remaining 40 patients were diagnosed with benign breast lesion. The age of benign breast lesion group was 40-76, and the average age was $51.0 \pm 6.0$. General information of both groups had no statistical difference.

### 1.2. Inclusion Criteria

①Female; ② MRI imaging data before treatment; ③ understood and consented the study, signed informed consent form; ④ the Ethics Committee approved.

### 1.3. Exclusion Criteria

① Women in pregnancy phase or lactation phase; ② combined with nervous system disease or unconsciousness; ③ combined with malignant tumor of other important organs or other severe diseases.

### 1.4. Method

GE750 3.0 MRI scanner was applied. All subjects adopted prone position, and both breasts naturally overhung in both holes of 4-channel special breast loop. MRI scanning, DWI and DCE scanning of both breasts and axillas for all patients were carried out, and the parameters are as follows:

$T_1WI$ (T1 weighted image): gradient echo sequence. Parameter setting: field of view (FOV): 340 mm; time of repetition (TR): 9600 ms; time of echo (TE): 68 ms; layer thickness: 4.0 mm; matrix: 269×448.

T2WI: fast spin echo sequence + frequency saturated fat inhibition. Parameter setting: FOV: 340 mm; TR: 4.0 ms; TE: 3650 ms; matrix: 314×320.

DWI: spin echo – echo planar imaging sequence. Parameter setting: FOV: 340mm; TR: 9600ms; TE: 68ms; layer thickness: 4.0mm; matrix: 64×132; diffusion coefficient (b) 300 s/mm², 600 s/mm², 800 s/mm².

DCE scanning: 3D volume interpolation method. Parameter setting: 360mm; TR: 4.67 ms; TE: 1.66 ms; layer thickness: 4.0 mm; matrix: 296×384; scanning time: 59 s. After completion of the first scanning, high pressure injector (rate 2.5 mL/s) was used to inject magnevist solution

and normal saline. Then, scanning was conducted continuously for 6 times.

### 1.5. Image Processing and Analysis Indicator

Two technical persons of radiology department used SIEMENS SYNGO software on the workstation to discuss images and carry out breast lesion analysis. In case of any divergence, they should solve it through negotiations.

#### 1.5.1. Scanning analysis

MRI analysis: nidus intensification features in the breast (yes, no); TIC type (inflow, platform, profile) [2].

DWI analysis: DWI signature performance (high/moderate/low signal); apparent coefficient (ADC), measure ADC values of mammary tissues in nidi and adjacent area of normal part (figure out the mean value of 3 measured values).

DCE scanning: measure region of interest in each phase and draw "time-signal intensity curve"; combine $T_1WI$, $T_2WI$, DWI and ADC to point out nidi, and carry out preliminary judgment and quantitative analysis of benign and malignant tumor.

#### 1.5.2. Image quality grading

The images were classified into three classes (A, B and C) according to dissection details, image artifact, artifact reconstruction and SNR [3].

### 1.6. Statistical Method

SPSS19.0 software as used for statistical treatment. $\chi^2$ test was adopted for enumeration data (%). T test was applied for measurement data ($\bar{x} \pm s$). $p<0.05$ means the difference has statistical significance.

## 2. Results

### 2.1. Scanning Difference

There were 51 nidi in breast cancer group, and 50 nidi in benign breast lesion group. The comparison of enhancement method and TIC type of both groups $p<0.05$. The differences had statistical significance. DWI signal comparison of both groups $p>0.05$. The difference had no statistical significance, as shown in Table 1.

**Table 1.** Comparison of scanning results.

| / | | Breast cancer group | Benign breast lesion group | $\chi^2$ | $p$ |
|---|---|---|---|---|---|
| DWI signal | High | 43 | 40 | 0.320 | 0.875 |
| | Moderate | 2 | 3 | 0.001 | 1.000 |
| | Low | 6 | 7 | 0.110 | 0.942 |
| Nidus enhancement | Yes | 0 | 6 | 4.541 | 0.031 |
| | No | 51 | 44 | | |
| TIC type | Inflow | 6 | 34 | 33.38 | 0.000 |
| | Platform | 20 | 10 | 4.460 | 0.037 |
| | Profile | 25 | 6 | 17.350 | 0.000 |

### 2.2. ADC

ADC value at nidus side in both groups was much lower than that of normal tissues ($p<0.05$), and the difference had statistical significance. ADC value at nidus side in breast cancer group was much lower than that of benign breast

lesion group ($p<0.05$), and the difference had statistical significance. The comparison of ADC value of normal tissues in both groups $p>0.05$, and the difference had no statistical significance, as shown in Table 2.

**Table 2.** Comparison of ADC values ($\times 10^{-3}$ mm$^2$/s).

| Group | Breast cancer group | Benign breast lesion group | $t$ | $p$ |
|---|---|---|---|---|
| Nidus side | $1.040 \pm 0.017$ | $1.560 \pm 0.021$ | -121.723 | 0.000 |
| Normal side | $1.811 \pm 0.015$ | $1.819 \pm 0.016$ | 2.307 | 0.086 |
| $t$ | -215.081 | -62.046 | / | / |
| $p$ | 0.000 | 0.000 | / | / |

Note: $b = 800$.

### 2.3. Image Quality

All patients were scanned successfully, and the number, size, shape, bur, enhancement, blood supply, surrounding invasion and transfer of nidi could be shown and achieve the diagnosis requirements. The proportion of Class-A images was 91.25%; the proportion of Class-B images was 7.50%; the proportion of Class-C images was 1.25%, as shown in Table 3.

**Table 3.** Image quality evaluation [n (%)].

| Group | Class A | Class B | Class C |
|---|---|---|---|
| Breast cancer group | 37 | 2 | 1 |
| Benign breast lesion group | 36 | 4 | 0 |
| Total | 73 (91.25) | 6 (7.50) | 1 (1.25) |

## 3. Discussion

3.0T MRI DWI combined with DCE scanning found that there were 51 nidi in breast cancer group, and 50 nidi in benign breast lesion group. All scanning images reached diagnosis requirements, from which the number, size, shape, bur, enhancement, blood supply, surrounding invasion and transfer of nidi could be known. The proportion of Class-A images was 91.25%; the proportion of Class-B images was 7.50%; the proportion of Class-C images was 1.25%. The technical essentials which should be noticed in the whole scanning process should include the following:

Firstly, to gain high-quality MRI images, the patients should keep motionless state in the examination process to reduce motion artifact.

Secondly, scanning sequence should be rationally chosen. Reasonable selection of scanning sequence includes different sequences and their combinations as well as sequence parameters. In combination of experience and relevant literatures, the complete scanning sequence should include:

① $T_1WI$ gradient echo sequence. Such sequence is a 3D fast imaging technology. It can measure all layers within a short time and gain multidirectional reconstructed images with high SNR [4]. Through unspaced scanning and reconstruction of images at each direction, it can avoid nidus omission and find deep nidus, mulifocality and multi-center nidi. In the first phase and delay phase of DCE scanning, this sequence was also adopted to gain images with high spatial resolution to show details of mammary tissues [5].

② $T_2WI$ fat inhibition sequence. Rich adipose tissues exist around human breast. To prevent high signal of adipose tissue from covering up lesion tissues, fat inhibition technology is required to generate short-time and uniform inversion recovery sequence.

DWI sequence adopts multichannel receiving coil and collects signals to effectively reduce examination time and improve time resolution.

④ "1+7 mode" is adopted for DCE scanning. After the masks in the first phase are scanned, medicine is used immediately, and scanning continues automatically for 6 phases after 25s. The region of interest is measured in each phase and "time-signal intensity curve" is drawn.

Thirdly, $b$ value should be chosen rationally during DWI. DWI can reflect the information of molecular level composed by human tissue space, and it is the sole clinical imaging method which can be used to observe microcosmic motion of living body [6]. Many experts and scholars have indicated that DWI owns important value of evaluating infiltration scope of breast cancer [7,8]. Malignant tumor has the feature of limited diffusion (including fast cell proliferation, high nuclear proportion and little gap) which can provide necessary information for differential diagnosis. ADC and cell density own good correlation. If ADV value of malignant tumor is small, the tumor is benign tumor [9,10]. The study found that, ADC value at nidus side in both groups was much lower than that of normal tissues ($p<0.05$), and ADC value at nidus side in breast cancer group was much lower than that of benign breast lesion group ($p<0.05$), which conforms to the conclusion. During practical scanning, the higher b value of DWI, the more sensitive to hydrone diffusion motion. But, this does not mean the higher b value, the better. If $b>1500$, anamorphose and missed diagnosis of small nidus will appear due to tissue signal attenuation. $b<500$ will be influenced by blood perfusion, thus leading to high ADC value. Most scholars consider 800 is the optimal choice of breast DWI [11,12].

## 4. Conclusion

In conclusion, it is required to select the correct scanning sequence, utilize fat saturation technique and choose proper b value during DWI in breast cancer examination so as to improve imaging time resolution, reduce image artifact and ensure image quality.

## References

[1] Eun Jung Choi, HyeMi Choi, Sin Ae Choi, Ji Hyun Youk. Dynamic contrast-enhanced breast magnetic reso-nance imaging for the prediction of early and late recur-rences in breast cancer. *Medicine (Baltimore),* **2016**, 95(48): e5330.

[2] Wegner C.S., Gaustad J.V., Andersen L.M.K., et al. Diffusion-weighted and dynamic contrast-enhanced MRI of pancreatic adenocarcinoma xenografts: associations with tumor differentiation and collagen content. Journal of Translational Medicine, **2016**, 14(1): 1-11.

[3] Hongying He, Jeri S Plaxco, Wei Wei. Incremental cancer detection using breast ultrasonography versus breast magnetic resonance imaging in the evaluation of newly diagnosed breast cancer patients. *Br. J. Radiol.*, **2016**, 89(1065): 20160401.

[4] Wang X.Y., Fei Y., Hui H., et al. Improved Performance in Differentiating Benign from Malignant Sinonasal Tumors Using Diffusion-weighted Combined with Dynamic Contrast-enhanced Magnetic Resonance Imaging. *Chinese Medical Journal*, **2015**, 128(5): 586-592.

[5] Zhou S., Yi Y., Li X. Comments on "Intravoxel incoherent motion diffusion-weighted imaging as an adjunct to dynamic contrast-enhanced MRI to improve accuracy of the differential diagnosis of benign and malignant breast lesions". *Magnetic Resonance Imaging*, **2017**, 36: 175-179.

[6] Nariya Cho, Wonshik Han, Boo-Kyung Han. Breast Cancer Screening With Mammography Plus Ultrasonography or Magnetic Resonance Imaging in Women 50 Years or Younger at Diagnosis and Treated With Breast Conservation Therapy. *JAMA Oncol.,* **2017**, 3(11): 1495-1502.

[7] Li R., Zhao Q., Xin S., et al. Diagnostic Accuracy of Dynamic Contrast Enhanced Magnetic Resonance Imaging and Diffusion-Weighted Imaging in Endometrial Carcinoma: A Retrospective Study on 54 Cases. Applied Magnetic Resonance, **2016**, 47(9): 1-9.

[8] Kuang F., Yan Z., Li H., et al. Diagnostic accuracy of diffusion-weighted MRI for differentiation of cervical cancer and benign cervical lesions at 3.0T: Comparison with routine MRI and dynamic contrast-enhanced MRI. *Journal of Magnetic Resonance Imaging*, **2015**, 42(4): 1094-1099.

[9] Hung-Wen Lai, Chih-Jung Chen, Ying-Jen Lin. Does Breast Magnetic Resonance Imaging Combined With Conventional Imaging Modalities Decrease the Rates of Surgical Margin Involvement and Reoperation: A Case–Control Comparative Analysis. *Medicine (Baltimore),* **2016**, 95(22): e3810.

[10] Vivian Youngjean Park, Eun-Kyung Kim, Min Jung Kim. Breast magnetic resonance imaging for surveillance of women with a personal history of breastcancer: Outcomes stratified by interval between definitive surgery and surveillance MR imaging. *BMC Cancer,* **2018**, 18: 91.

[11] Kandace P. McGuire, E. Shelley Hwang. Surgical Patterns of Care in Patients with Invasive Breast Cancer Treated with Neoadjuvant Systemic Therapy and Breast Magnetic Resonance Imaging: Results of a Secondary Analysis of TBCRC 017. *Ann. Surg. Oncol.*, **2015**, 22(1): 75-81.

[12] Jeon-Hor Chen, Min-Ying Su. Clinical Application of Magnetic Resonance Imaging in Management of Breast Cancer Patients Receiving Neoadjuvant Chemotherapy. *Biomed Res Int.,* **2013**, 2013: 348167.