CASE REPORT

Diffusion-weighted Imaging for Parasternal Lymph Nodes in Breast Cancer: Report of Two Cases

Yuko KATAOKA1, Yoriiko MURATA2*, Kana MIYATAKE2, Michiko TADOKORO2, Kimiko NAKATANI2, Kei KUBOTA2, Norihiko HAMADA2, Akihito NISHIOKA2, and Yasuhiro OGAWA2

1Department of Radiology, Hata Kenmin Hospital
3–1 Yoshina, Yamana-cho, Sukumo, Kochi 788-0785, Japan
2Department of Radiology, Kochi Medical School

We report 2 cases of primary breast cancer with swelling of the parasternal lymph nodes detected on diffusion-weighted imaging (DWI) as small parasternal nodules. After neoadjuvant chemotherapy, DWI showed disappearance of one node but a focus of subtle signal hyperintensity in the other. DWI findings correlated with the results of conventional breast contrast-enhanced magnetic resonance imaging before and after neoadjuvant chemotherapy.

Keywords: breast cancer, diffusion-weighted imaging, MRI, parasternal lymph nodes

Introduction

In primary breast cancer, parasternal staging is related to prognosis, greatly influences treatment strategy, and is typically defined by image assessment. Diffusion-weighted imaging (DWI) has recently become more widely used in the field of breast disease but to the best of our knowledge, its use for parasternal staging has not been reported. Because apparent diffusion coefficient (ADC) values obtained by DWI reflect the biological characteristics of tissue, such imaging could be useful in evaluating parasternal lymph nodes in patients with primary breast cancer. We report 2 cases in which detection of parasternal lymph nodes was comparable between DWI and conventional magnetic resonance (MR) imaging.

Case Reports

Case I

A 50-year-old woman visited our hospital with a palpable tumor in the left breast that was diagnosed as invasive ductal breast carcinoma on the basis of ultrasonography-guided fine needle biopsy. Prior to treatment, the patient underwent DWI and conventional gadolinium-enhanced MR imaging and whole-body positron emission tomography (PET)-computed tomography (CT) using 2-deoxy-2-[18F]fluoro-D-glucose (FDG-PET-CT). Conventional dynamic MR imaging and DWI were performed with the subject prone on a 1.5-tesla unit (Signa HDx; GE Healthcare, USA).

We performed dynamic MR imaging using a 3-dimensional fast spoiled gradient-echo sequence (VIBRANT) (repetition time [TR], 5.0 ms; echo time [TE], 2.7 ms; flip angle, 10°; field of view [FOV], 28 × 28 cm; matrix, 512 × 512; slice thickness, 3 mm; NEX, 1) before and 8 times (once every 30 s) after administering bolus injection of gadolinium-diethylenetriamine pentaacetic acid (Gd-DTPA) at 0.1 mmol/kg body weight through an automatic injector at a rate of 3 mL/s followed by a 50-mL saline flush.

We acquired bilateral transverse DWI with b-values of 0 and 1500 s/m² before administration of contrast material (TR, 5000 ms; TE, 68.0 ms; flip angle, 90°; FOV, 36 × 36 cm; matrix, 160 × 160; slice thickness, 3 mm; NEX, 4). Two experienced radiologists evaluated DWI and results of conventional MR imaging by consensus.

Parasternal lymph nodes were defined as a focus of signal hyperintensity on DWI and a focus of enhancement on conventional MR imaging (Fig. 1a, b). We measured ADC values by DWI and long-axis diameter by conventional MR imaging in all identifiable parasternal nodules.
We calculated ADC values according to the following formula: $$\text{ADC} = \frac{\ln S(h)/S(l)}{b(h) - b(l)}$$, where $\ln$ is the natural log, and $S(h)$ and $S(l)$ are the signal intensities in each region of interest (ROI) placed on sections corresponding to 2 different $b$ factors ($b = 1500$ or $0 \text{s/mm}^2$). In obtaining ADC values of lesions, we carefully placed ROIs within the area of highest signal intensity in the parasternal region on DWI.

DWI revealed a parasternal nodule with hyperintensity (ADC, $0.885 \times 10^{-3} \text{mm}^2/\text{s}$). Contrast-enhanced $T_1$-weighted imaging demonstrated a parasternal nodule with a long-axis diameter of 7.8 mm.

Using a dedicated whole-body scanner (Discovery ST Elite; GE Healthcare, USA), we initiated PET-CT scanning 50 min after intravenous administration of 3.5 MBq/kg of FDG. An experienced radiologist visually evaluated PET-CT and observed no parasternal accumulation.

The patient underwent neoadjuvant chemotherapy (NAC) (4 courses of epirubicin at 100 mg/m$^2$ and cyclophosphamide at 600 mg/m$^2$ [EC]) according to our hospital protocol for primary tumors exceeding one centimeter in diameter. After 4 courses of NAC, parasternal nodules were not apparent on DWI, conventional MR imaging (Fig. 1c, d), or PET-CT. The patient is alive without other metastasis 3 years since breast-conserving surgery without parasternal lymph node dissection and 4 courses of postoperative systemic chemotherapy.

Case 2

A 59-year-old woman visited our hospital with a palpable tumor in the right breast that was diagnosed as invasive ductal breast carcinoma based on ultrasonography-guided fine needle biopsy. DWI revealed a parasternal nodule with hyperintensity (ADC, $0.873 \times 10^{-3} \text{mm}^2/\text{s}$) (Fig. 2a); contrast-enhanced $T_1$-weighted imaging demonstrated a parasternal nodule with a long-axis diameter of 13.4 mm (Fig. 2b); and FDG-PET-CT demonstrated subtle parasternal accumulation. After 4 courses of NAC (EC), a parasternal nodule appeared as a focus of subtle enhancement with a long-axis diameter of 3 mm (ADC $1.30 \times 10^{-3} \text{mm}^2/\text{s}$) (Fig. 2c, d). FDG-PET-CT demonstrated no parasternal nodules. The patient is alive without other metastasis 3 years since breast-conserving surgery without parasternal lymph node dissection and 4 courses of postoperative systemic chemotherapy. After postoperative chemotherapy, the parasternal nodule disappeared on DWI and conventional MR imaging.

Discussion

Diffusion-weighted imaging has recently become more widely used in the field of breast disease.\textsuperscript{3-10}
Fig. 2. A 59-year-old woman with invasive breast carcinoma
(a) Diffusion-weighted imaging (DWI) shows a parasternal nodule with high intensity (apparent
diffusion coefficient [ADC], $0.873 \times 10^{-3}$ mm$^2$/s). (b) Contrast-enhanced T$_1$-weighted imaging
shows a parasternal nodule with a long-axis diameter of 13.4 mm. (c) After neoadjuvant chemother-
apy (NAC), the parasternal nodule appears as a focus of subtle high intensity (ADC, $1.30 \times 10^{-3}$
mm$^2$/s). (d) After NAC, the parasternal nodule appears as a focus of subtle enhancement with a
long-axis diameter of 3 mm. Appearance is similar to an internal mammary vessel.

but its role in the evaluation of parasternal staging
has yet to be determined. In our 2 cases, findings
from DWI and conventional MR imaging were
equivalent for detecting parasternal lymph nodes
before and after NAC.

PET-CT findings differed from those of DWI
and conventional MR imaging in these 2 cases.
PET has been shown highly useful for detection
and/or staging of tumors but has limited sensitivi-
ity for detecting cancers smaller than one cen-
timeter. A tumor’s histological grade has been
reported as a strong predictor of PET-CT results.
In Case 1, tumor size could have been a factor con-
tributing to false-negative PET-CT findings, and in
Case 2, after NAC, tumor size and histological
changes due to NAC could have been factors.

The importance of ADC obtained by DWI has
been reported in diagnosing benign and malignant
lymph nodes in various regions. ADCs tend to
be higher in benign lymph nodes and are reported
significantly lower in metastatic than nonmetastatic
lymph nodes. Although a threshold diameter of
10 mm in the short axis is commonly applied on
MR imaging to distinguish metastatic from benign
nodes, sensitivity is not high. Recently, the
combination of size and relative ADC values has
been reported useful in detecting lymph node
metastasis from cervical and uterine cancers.

DWI has gained more attention for diagnosing
lymph node metastases. We did not consider lymph
node size, only ADC. However, ADC values in
these 2 cases could have been low enough to be con-
sidered indicative of malignancy.

Although we regarded conventional MR imaging
as the gold standard modality for imaging to detect
parasternal lymph nodes, neither of the 2 paraster-
nal lesions was diagnosed pathologically. Negative
findings on MR imaging may not always indicate
pathologically negative results. However, para-
stellar staging of breast cancer is determined by imag-
ing modality in the TNM classification. Paras-
stellar lymph node swelling is classified as N2b breast
cancer without axillary lymph node swelling or N3b
with axillary swelling; breast cancer with paraster-
nal lymph node swelling is classified as stage IIIA
or above, regardless of T factor. Para-sternal stag-
ing is clinically important in patients with primary
breast cancer for determining treatment strategies
and/or long-term management.

Bilateral breast MR imaging, in which the ster-
num is located in the central portion between the
breasts, has recently been considered essential for
detecting tumor associated with the contralateral
breast. Although axillary lymph nodes may lie
outside the imaging area, parasternal lymph nodes
are not missed.
DWI offers excellent contrast resolution, although conventional enhanced MR imaging has superior spatial resolution to DWI. On DWI, vessels did not influence parasternal lymph nodes, although on conventional MR imaging, small lymph nodes were easily confused with neighboring internal mammary vessels because both lymph nodes and vessels were enhanced.

Although our results suggest the usefulness of DWI for detecting parasternal lymph nodes in breast cancer before and after NAC, neither of the 2 parasternal lesions was diagnosed pathologically. We did not differentiate between benign and malignant parasternal lymph nodes based on ADC values. Thus, a larger clinical study is needed to confirm the findings from these cases.

In conclusion, we report 2 cases of primary breast cancer in which demonstration of parasternal lymph node swelling on DWI was equal to that of conventional MR imaging. We propose DWI as a potential tool for assessing effects of parasternal NAC in patients with breast cancer. Combined with conventional MR imaging, DWI could be expected to facilitate monitoring of such therapeutic effects in breast cancer.

Acknowledgements

We wish to thank Kazuo Morio, Hiroaki Yasunami, Shin Yaogawa, and Ichiro Morita for their excellent technical assistance and generous support.

References


19. Kim JK, Kim KA, Park BW, Kim N, Cho KS. Feasibility of diffusion-weighted imaging in the...

