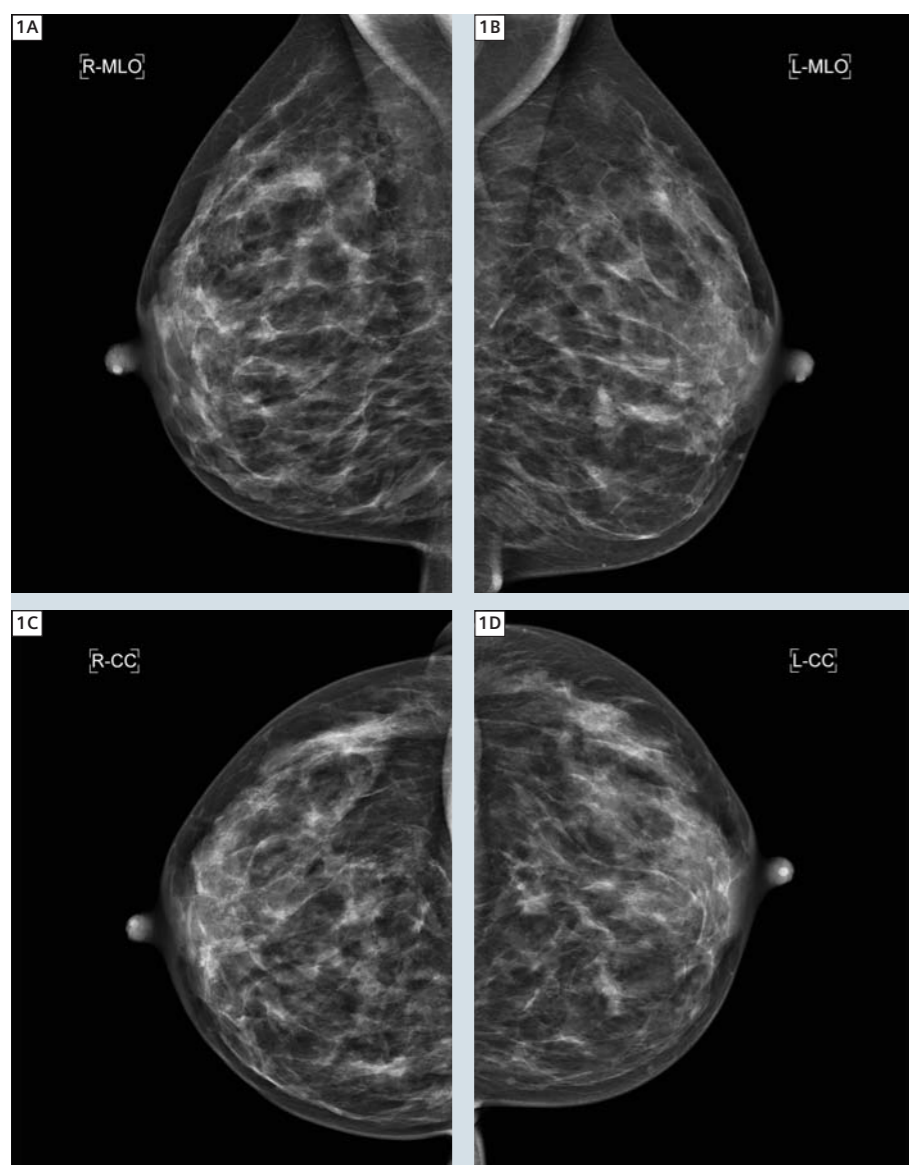


Case Report: Role of DWI for Lesion Discrimination in Breast MRI of Multifocal and Contralateral Breast Cancer

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1 Mammography in mediolateral and craniocaudal projection of both breasts.

Patient history

We report on a 35-year-old woman who presented with a small nodule around the nipple which she palpated since one week. She had no prior breast surgery. She had a positive family history of breast cancer. One sister at 26 years of age and one sister at 33 years of age. Mammography showed inhomogeneous, symmetrically distributed fibroglandular breast tissue and no obvious abnormality (Fig. 1). On ultrasound the palpable nodule was oval in shape with inhomogeneous echogeneity and a size of 9 mm. It was classified as a BI-RADS 4 (1) lesion. Before the ultrasound guided biopsy an MRI of both breasts was performed for further evaluation of the palpable mass and due to the strong family history for breast cancer.

Sequence details

Images were acquired on a 1.5 T scanner (MAGNETOM Avanto, Siemens Healthcare) using a dedicated 4-channel diagnostic breast coil (Siemens Healthcare) with the patient in prone position. Our standard breast MRI protocol includes the following sequences: An axial **2D T2-weighted STIR pulse sequence** (TR/TE/TI, 7200/85/150 msec, FOV 380 x 380 mm, matrix = 512 x 358, resolution: 1.1 x 0.7 x 3.0 mm, acquisition time: 3:30 min), A pre- and post-contrast **sagittal T1-weighted 3D gradient echo (GRE) pulse sequence** (TR/TE, 21/4.8 msec, FOV 180 x 180 mm, matrix = 512 x 512,



2 MIP-reconstruction. Two lesions in the right breast and one lesion in the left breast are delineated.

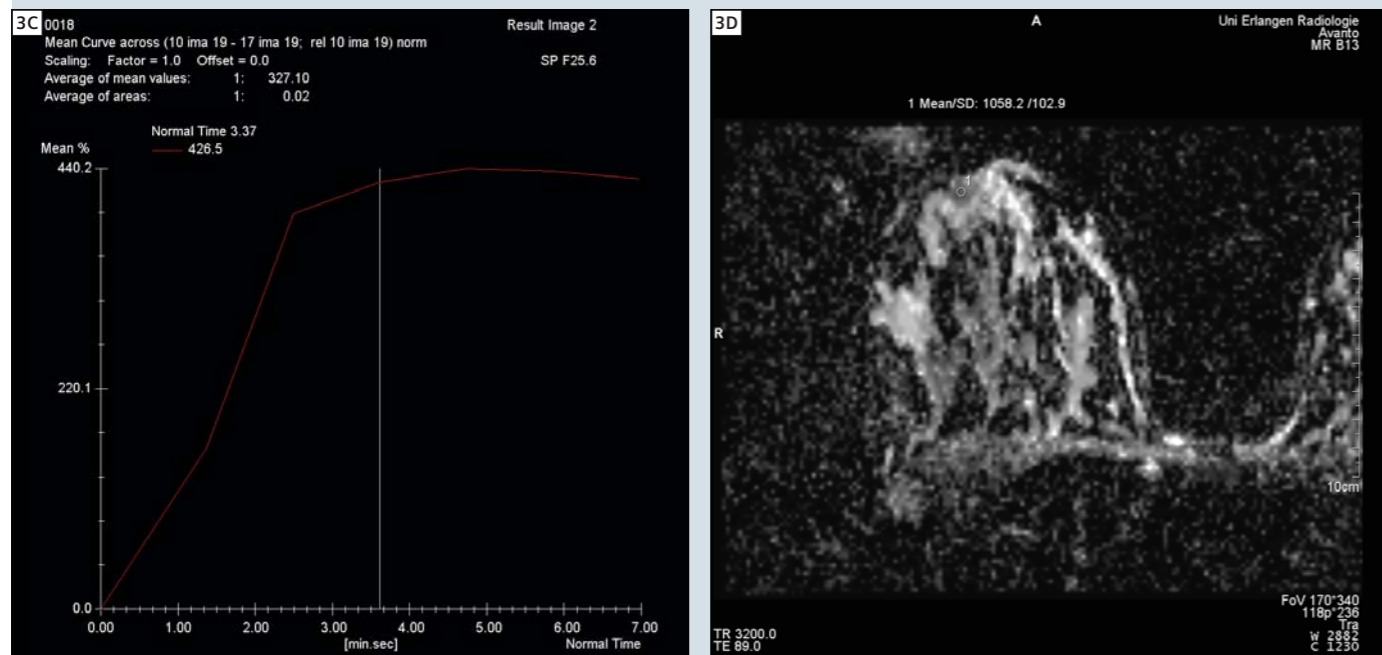
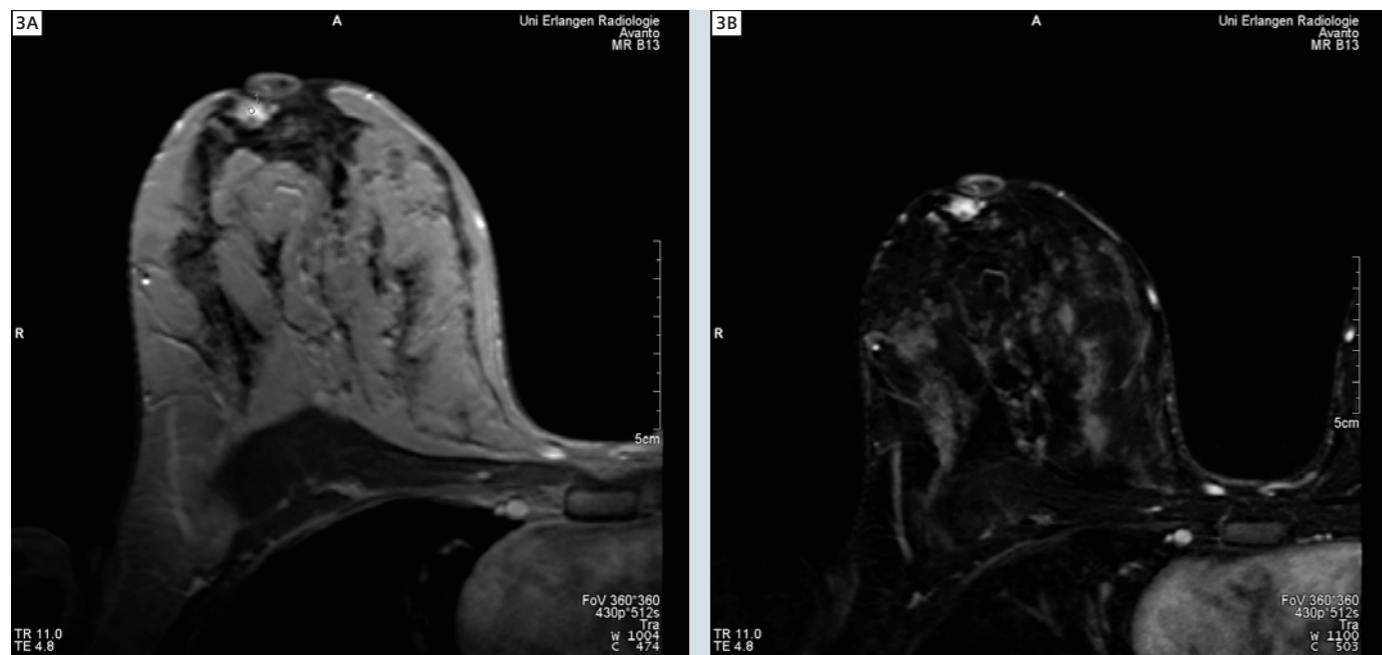
resolution: 0.4 x 0.4 x 2.0 mm, acquisition time: 4:42 min), And an **axial 3D dynamic GRE pulse sequence** (TR/TE, 11/4.8 msec, FOV 360 x 360 mm, matrix = 512 x 430, resolution: 0.8 x 0.7 x 3 mm, acquisition time per time point: 1:07 min, total 6 time points including one native scan). Diffusion-weighted (DW) images were acquired in axial slice orientation using a EPI-SE sequence. Fat signal suppression was obtained by applying water selective excitation pulses (TR/TE, 3200/89, FOV 340 x 170 mm, matrix = 236 x 118, resolution 1.4 x 1.4 x 4 mm). The relatively high spatial resolution could be achieved by using parallel imaging with

GRAPPA acceleration factor of 2 in the anterior-posterior direction. DWI measurements were acquired in three averages of 26 slices with 4 mm slice thickness and b-values of 50, 400 and 800 s/mm² using 3-scan trace calculation resulting in a scan time of only 1:42 minute. Apparent diffusion coefficient (ADC) maps were calculated automatically using the scanner software.

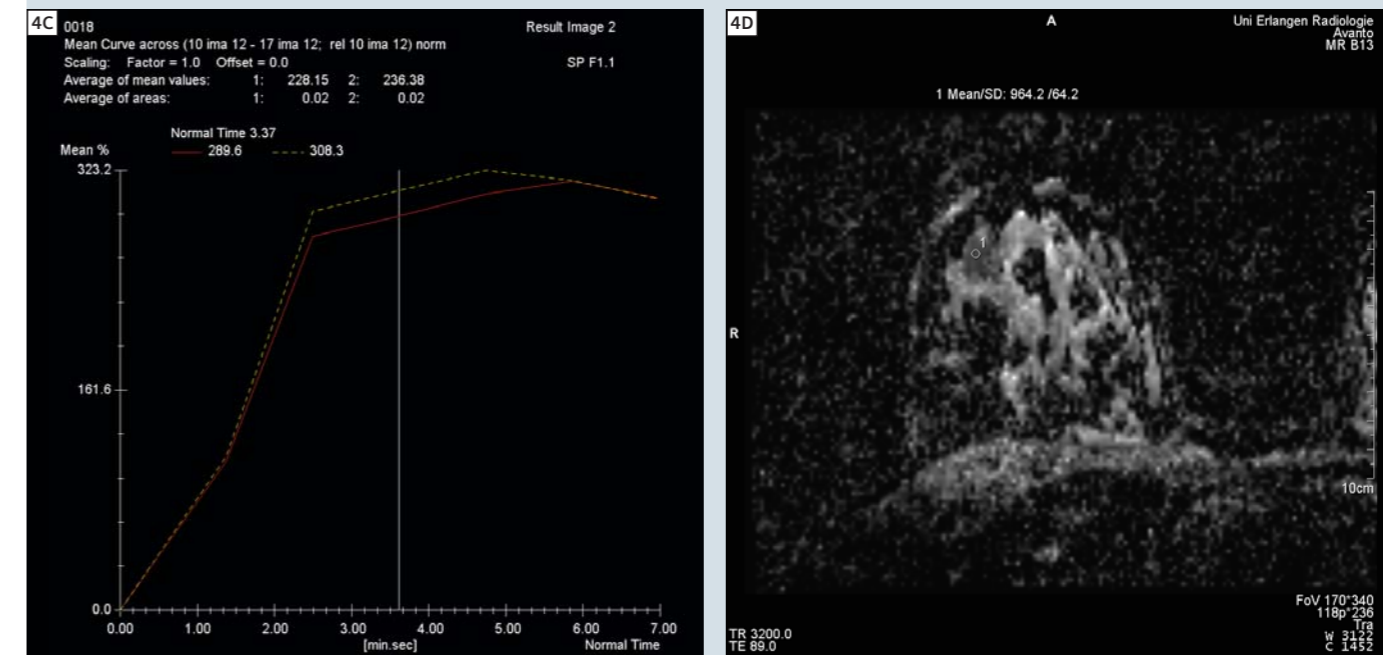
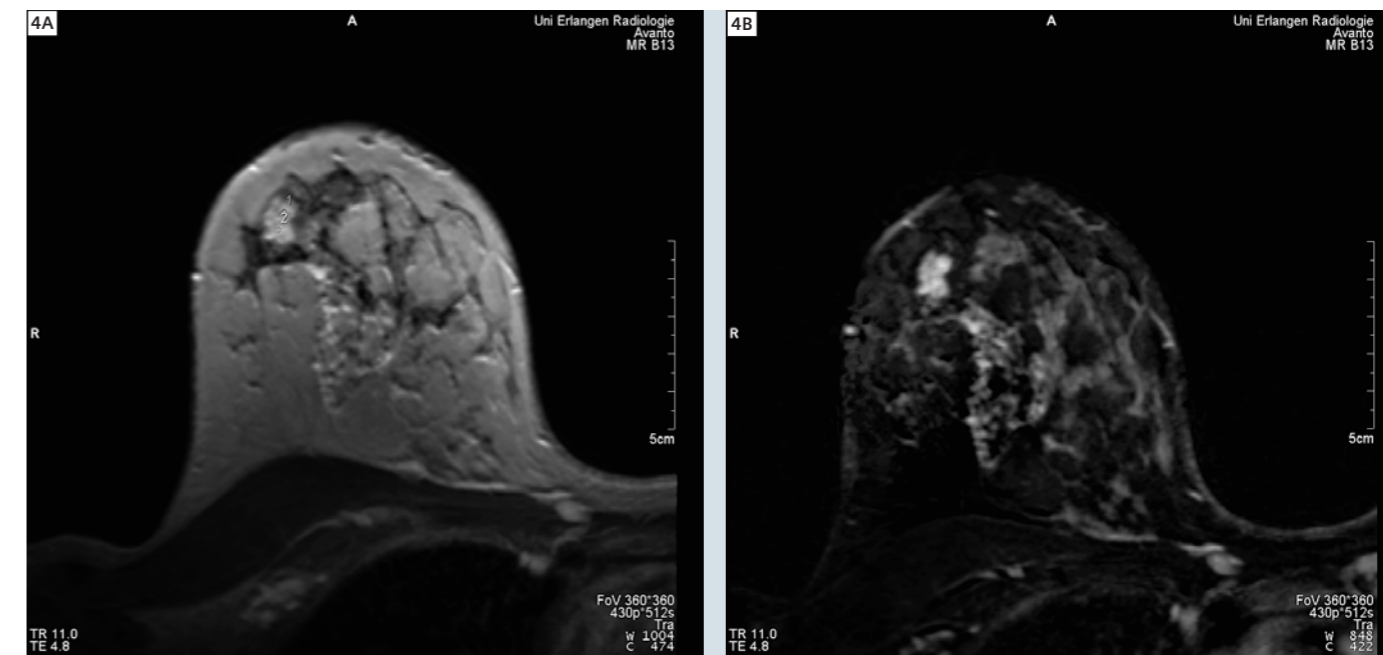
Imaging findings

Besides inhomogeneous enhancing fibroglandular breast tissue two lesions in the right breast and a contralateral lesion in the left breast were identified on MRI. In the MIP reconstruction based

on dynamic MRI the three lesions are clearly visible (Fig. 2). All three lesions were evaluated according to morphologic and dynamic MR features and DWI values. ADC values for malignant breast lesions range from 0.9 x 10⁻³ mm²/s to 1.2 x 10⁻³ mm²/s and for benign lesions from 1.5 x 10⁻³ mm²/s to 1.8 x 10⁻³ mm²/s (with cysts >2, if included) in recent publications [2–7]. In a series of our patients mean ADC values for malignant lesions were 0.9 x 10⁻³ mm²/s (± 0.18) and for benign lesions 1.8 x 10⁻³ mm²/s (± 0.42) [2].



3 Lesion 1 in an early T1-weighted image with ROI for dynamic analysis (A), subtraction image (B), dynamic curve (C) and ADC value (D). Mean ADC values and standard deviation are given in mm²/s.



4 Lesion 2: T1-weighted image with ROI for dynamic analysis (A), subtraction image (B), dynamic curve (C) and ADC value (D).

The oval to lobular shaped perimamillary lesion with a size of 8 x 9 mm (Fig. 3) corresponded to the palpable lesion. The second lesion (Fig. 4) in the right breast measured 1.1 x 0.7 cm and was located at 11 o'clock with lobulated to irregular margins. The irregular shaped mass in the left breast at 8 o'clock measured 1.9 x 2.1 cm (Fig. 5). The signal-intensity (SI) time curve was

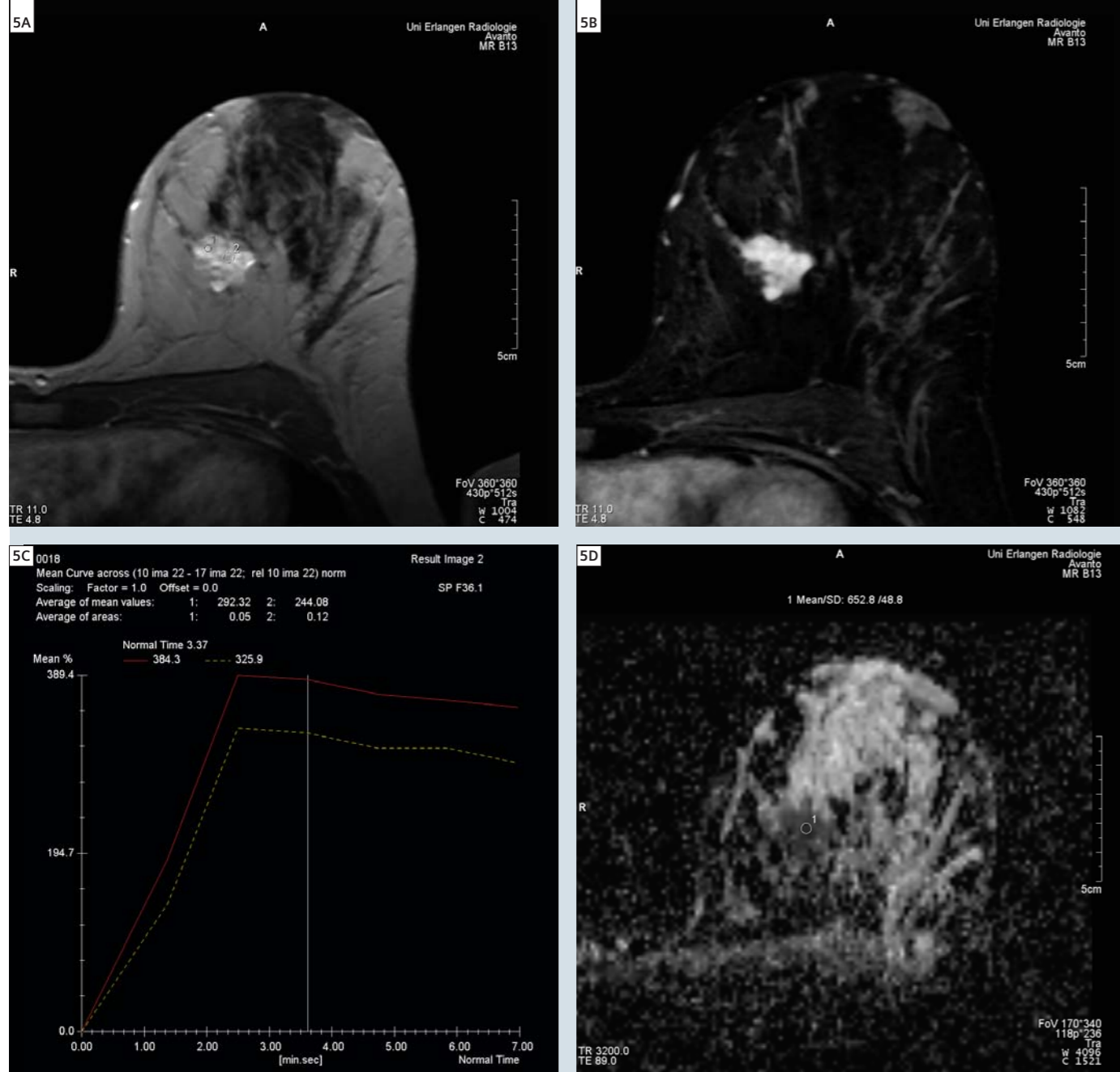
initially steep in all lesions. The maximum SI of the lesion in the left breast was after 2 minutes followed by a fast SI decrease. The lesions in the right breast showed similar shaped SI time curves with continuous rise of the SI discretely after two minutes and with an SI plateau in the following dynamic scans. The ADC values indicated malignancy for all lesions with a value of $1.1 \times 10^{-3} \text{ mm}^2/\text{s}$

in lesion 1, $1.0 \times 10^{-3} \text{ mm}^2/\text{s}$ in lesion 2, and $0.7 \times 10^{-3} \text{ mm}^2/\text{s}$ in lesion 3. The lesions in the right breast were not clearly suggestive of malignant disease according to their morphologic features as potential differential diagnosis could be sclerosing adenosis, fibrocystic disease or fibroadenoma. Lesion 3 was highly suggestive of breast cancer in its morphological, dynamic and diffusibility criteria.

After the MRI a second look ultrasound was performed. The mass in the left breast was identified as an inhomogeneous area in the breast and biopsied ultrasound guided. Histology revealed an intermediate differentiated invasive, focally mucous producing breast cancer with intermediate grade DCIS. The ultrasound guided biopsy of the palpable lesion in the right breast was a highly

differentiated invasive ductal breast cancer. The second lesion in the right breast could not be identified on ultrasound. An MR-guided vacuum assisted biopsy was performed of this lesion and histology revealed a highly differentiated invasive ductal breast cancer. After neoadjuvant chemotherapy the patient underwent skin-sparing mastectomy of both sides. Histology of the

mastectomy specimen revealed residuals of an intermediate grade DCIS of 2 cm in the outer quadrant of the right breast and an intermediate differentiated invasive breast cancer of 12 mm with one micrometastasis in an axillary lymph node.



5 Lesion 3: T1-weighted image with ROI for dynamic analysis (A), subtraction image (B), dynamic curve (C) and ADC value (D).

Diffusion-Weighted Imaging for Characterizing Breast Lesions Prior to Biopsy

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Introduction

Diffusion-weighted imaging (DWI) is characterized by superior lesion to background contrast, and it has been applied in the brain e.g. to diagnose early-stage cerebral infarction. When used to image the body, however, strong artifacts are created by the non-uniformity of the magnetic field. Recent development of MR technology has nearly overcome this obstacle and enabled the clinical application of DWI. DWI has shown great promise in the detection of most tumor types throughout the entire body. Regarding breast DWI, the potential role of the apparent diffusion coefficient (ADC) in characterizing breast lesions has been reported. Preliminary results showed that ADC value may be an effective parameter for distinguishing between benign and malignant breast lesions because tumor cellularity has a significant influence on ADC values [1–3].

Optimal b-values

However, there is no international consensus in regard to the usefulness of DWI for breast cancer or the optimal b-values. Therefore, we perform categorization visually based on multi-b-factor DWI (500, 1000, 1500, 2000 and 3000 s/mm²), always applying the same window level and width. The significance of the five b-values at our institution is being investigated, particularly whether very high b-values of 2000 s/mm² or more might be useful for evaluating the effects of neoadjuvant chemotherapy. Currently, we routinely perform ADC calculations based on two b-values: 500 s/mm² and 1500 s/mm².

Interpretation of DWI: two-step evaluation for mass lesion

We previously reported the clinical usefulness of DWI using a two-step evaluation to detect rectal cancer [4]; we are testing a similar approach for breast

mass lesions. First, high b-value (b = 1500 s/mm²) images were assessed visually. Next, ADC values of mass lesions were calculated among the patients with positive results on DWI. The highest signal portion of the lesion was visually identified on original high b-value images, and a circular region of interest (ROI) was placed manually on that portion of the lesion. ADC values were calculated according to the equation

$$ADC \text{ (mm}^2\text{/s)} = 1/b_2 - b_1 \times \ln[IS(b_1)/IS(b_2)]$$

where IS(b₁) and IS(b₂) are the signal intensities resulting from two different gradient factors, b₁ = 500 and b₂ = 1500 s/mm².

At our institute, ADC measurements are not performed for non-mass type lesions because it is sometimes impossible to identify the highest signal portion at one location in the lesions.

Conclusion

DWI can be helpful to support diagnosis of cancerous breast lesions.

References

- 1 ACR. Breast Imaging Reporting and Data System Atlas (BI-RADS Atlas), BI-RADS – Mammography, Fourth Edition. BI-RADS - Ultrasound, First Edition. BI-RADS – MR Imaging, First Edition. Reston, VA., 2003.
- 2 Wenkel E, Geppert C, Schulz-Wendtland R, et al. Diffusion weighted imaging in breast MRI: comparison of two different pulse sequences. Acad Radiol 2007; 14:1077–1083.
- 3 Woodhams R, Matsunaga K, Iwabuchi K, et al.

Diffusion-weighted imaging of malignant breast tumors: the usefulness of apparent diffusion coefficient (ADC) value and ADC-map for the detection of malignant breast tumors and evaluation of cancer extension. J Comput Assist Tomogr 2005; 29:644–649.

- 4 Woodhams R, Matsunaga K, Kan S, et al. ADC mapping of benign and malignant breast tumors. Magn Reson Med Sci 2005; 4:35–42.
- 5 Kuroki Y, Nasu K, Kuroki S, et al. Diffusion-weighted imaging of breast cancer with the sensitivity encoding technique: analysis of the apparent diffusion coefficient value. Magn Reson Med Sci 2004; 3:79–85.
- 6 Rubesova E, Grell AS, De Maertelaer V, Metens T, Chao SL, Lemort M. Quantitative diffusion imaging in breast cancer: a clinical prospective study. J Magn Reson Imaging 2006; 24:319–324.

- 7 Marini C, Iacconi C, Giannelli M, Cilotti A, Moretti M, Bartolozzi C. Quantitative diffusion-weighted MR imaging in the differential diagnosis of breast lesion. Eur Radiol 2007; 17:2646–2655.

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