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Short report

Short first-pass MRI of the breast

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Abstract

To reduce examination time and costs, a new concept for MRI of the breast is presented. This short first-pass MRI takes 4–5 minutes and could be applied to approximately three-quarters of all women.

Keywords: Breast, MRI, breast cancer, first-pass imaging

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Contrast-enhanced quality-assured MRI of the breast is the most sensitive method for the detection of breast cancer at an early stage compared to other imaging modalities like mammography and ultrasound (1). Prerequisites for high quality MRI are an open breast surface coil, an integrated compression device and a technique using a high spatial resolution (matrix 512 × 512). Comfort aspects are also important to reduce motion artifacts. MRI protocols usually include a dynamic sequence before and repetitively after intravenous administration of a contrast material for 8–10 minutes (2). Postprocessing includes subtraction of pre- and post-contrast images for better visualization of enhancing lesions. In addition, a fluid-sensitive T2 measurement is performed to optimize the characterization of enhancing findings (3).

The typical strong uptake of contrast material in breast cancer is due to tumor neoangiogenesis. The maximum contrast enhancement in carcinomas is found within the first three minutes after peripheral venous application, while normal parenchyma usually shows a slow increasing uptake of the contrast material. As a result, the relevant time slot for a good differentiation between breast cancer and normal surrounding tissue are the first minutes after contrast injection. Later, the wash-out seen in malignant tumors, as well as the increasing enhancement of normal parenchyma, makes the depiction of breast cancer increasingly difficult. The acquisition of the first-pass in-breast enhancement is therefore essential for a reliable detection of small breast cancer. Later measurements are necessary only for characterization of enhancing lesions. If there is no ambiguous in-breast enhancement, however, then there is no need for imaging later than 4–5 minutes after contrast administration. Moreover, there is also no need for T2 imaging. Major criteria for image analysis are based on morphologic aspects. Signal-to-time curves have a lower relevance. As a consequence, a shortened MRI protocol was inaugurated, which allows a complete examination within a measurement time of 4–5 minutes using established sequences (Table 1). Visual evaluation of subtraction images and the MIP image takes 8–10 s for women without any findings and can be supplemented by a dedicated MRI-CAD system (Fig. 1). In cases where enhancing lesions or disturbing early enhancement due to hormonal stimulation are detected, the protocol can be extended by subsequently performing up to five measurements after contrast administration and an additional T2-weighted imaging (Figs. 2–4) (4).

An important indication for short first-pass MRI of the breast is breast cancer in women with mammographic density type III and IV (American College of Radiology) because of the reduced sensitivity of mammography to approximately 40% (5). In a screening population, the proportion of women with density types III and IV in mammography ranges from 40% to 50% (1, 5). In comparison, the proportion of women with MRI density types III and IV ranges from 5% to 10% (4).

Table 1 Measurement protocol for short first-pass MRI of the breast

System	1.5 T
Technique	3D
Sequence	T1 gradient echo
TR (msec)	8.4
TE (msec)	4.1
Matrix	512 × 512
Slice thickness (mm)	2
Time per sequence (s)	87
Total time (1 pre and 2 post) (min)	4:35

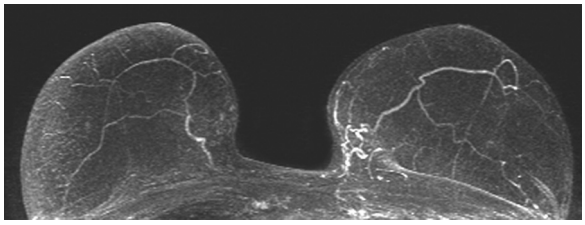

Fig. 1 Normal findings. Short first-pass MRI of the breast. Normal findings on MIP-technique acquired after a total measurement time of 4:35 min

In our patient collective, the breast MRI of 75% of women in a screening population shows no ambiguous findings and could be examined using the short MRI protocol. Screening MRI could be recommended for these women every 1–2 years. Moreover, in light of the results from the German EVA trial it should be a matter of discussion as to whether or not women with inconspicuous MRI findings need any additional diagnostics such as digital mammography or ultrasound (1). Patients with a solitary focus are placed in the MRI BI-RADS category 3. They are therefore advised to perform a follow-up MRI in 6 months (4). Patients with a lesion categorized to MRI BI-RADS 4 or 5 are recommended to undergo percutaneous biopsy for histologic clarification.

Compared to breast MRI measurement protocols in the past, short first-pass MRI of the breast allows a relevant shortening of the examination time. The relevant data for

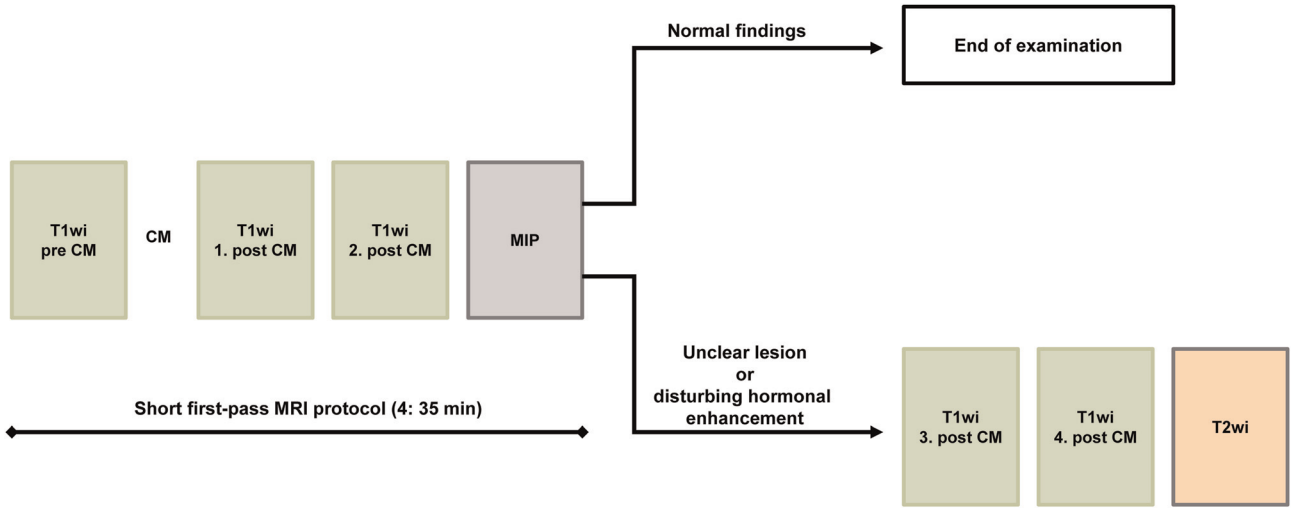

Fig. 2 Shortened MRI protocol in a screening constellation. Principle of short first-pass MRI with a total examination time of 4:35 in case of normal findings

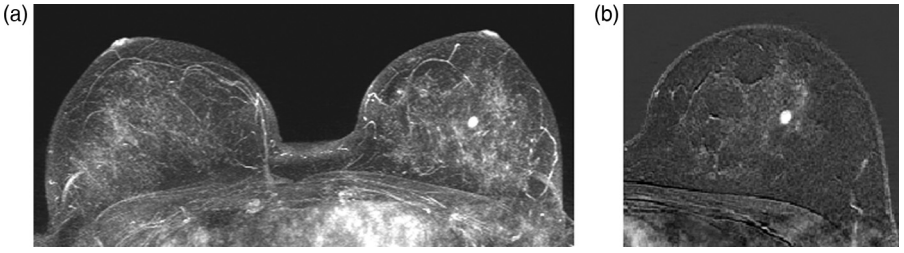

Fig. 3 Fibroadenoma. MRI of the breast. MIP technique (a) and the single slice subtraction image of the left breast (b) show an oval mass with well-defined borders and homogeneous uptake of the contrast material

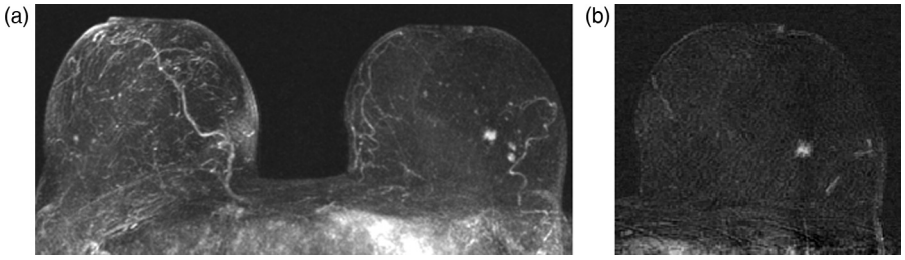

Fig. 4 Tubular breast carcinoma. MRI of the breast. MIP technique (a) and the single slice subtraction image of the left breast (b) show an irregular mass with spiculated borders

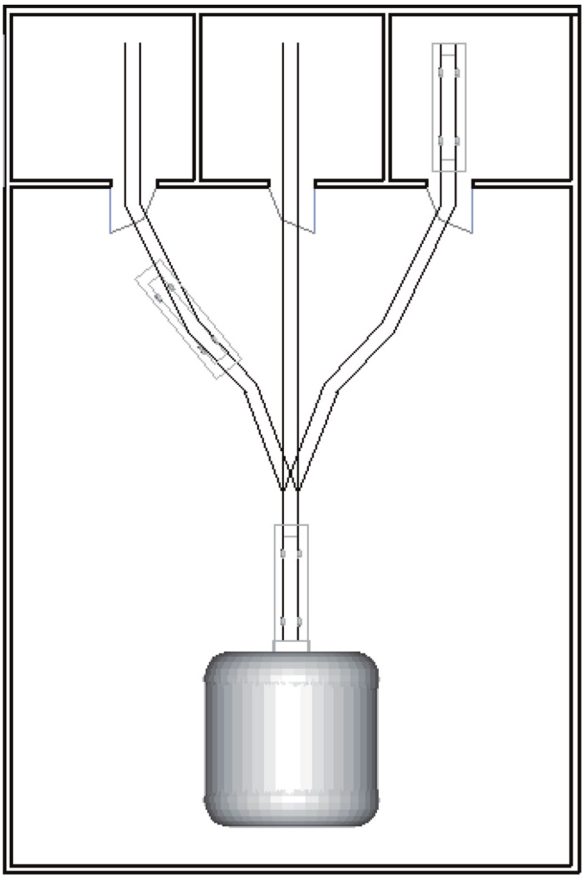

Fig. 5 MRI system with three tables/three cabins. Optimization of short first-pass MRI using multiple examination tables for patient preparation

detection of breast cancer can be acquired within a time slot of 4–5 minutes. This protocol avoids unnecessary time expenditure in women without hormonally induced enhancement or abnormal findings. In a screening-relevant collective (women aged 40–70 years), the shortened protocol could be applied to approximately three-quarters of all women. This approach allows a higher examination rate and/or a reduction of the cost per MRI. The effectiveness could be further increased when an MRI system with two or three tables is used to reduce the time for positioning each patient (Fig. 5).

In conclusion, combining these considerations with a reasonable price reduction of contrast material, the overall cost of breast screening MRI can be realistically reduced to about €250. In a 2-year interval MRI screening program, this is the equivalent of €10 per woman per month and allows a reliable detection of breast cancer at early stage (DCIS, pT1a, pT1b).

Conflict of interest: None.

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