Feasibility of MRI-guided large core-needle biopsy of suspiscious breast lesions at 3T

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Introduction

Magnetic Resonance Imaging (MRI) of the breast is a promising diagnostic modality with a sensitivity approaching 100% and a reasonable specificity for the detection of invasive breast tumors. Approximately 10% of patients with a malignant breast lesion detected on mammography has an additional malignancy that is mammographically and ultrasonographically occult, but can be visualized by means of MRI. Its high sensitivity makes Breast MRI a good diagnostic modality for preoperative staging in breast cancer patients. When an additional suspicious breast lesion is detected on MR images that is occult on other imaging modalities, MRI-guided biopsy of these lesions is required. MRI systems operating at high magnetic fields strengths (e.g. 3T) become increasingly available in the clinical setting. The possibility of acquiring high-resolution images in a shorter period of time, nominates 3-T breast imaging as a promising alternative to 1.5-T imaging for diagnostic purposes. The possibility of decreasing scan time while retaining an acceptable signal-to-noise ratio (SNR) and spatial resolution makes high field MRI appealing for interventional purposes as well. However, if breast biopsies were to be performed at 3T, the susceptibility artifact of the needle would become larger and could complicate accurate tissue sampling. Therefore, we assessed the feasibility of 3-T MRI-guided large core-needle biopsy of suspicious 'MRI-only' breast lesions.

Materials & Methods

Patient characteristics 31 suspicious MRI-only breast lesions in 30 women (mean age 48; range 29-78 years) were detected. Indications for diagnostic breast MRI were problem solving (n=11), increased risk of breast cancer (n=7), preoperative staging (n=3), work-up of a nonpalpable breast lesion (n=5), tumor positive axillary lymph node with negative mammography (n=1), bloody nipple discharge (n=2) and unknown (n=2). Patients were referred for MRI-guided biopsy from 10 different hospitals. Of the 32 lesions, 18 lesions were characterized as BI-RADS III, 9 lesions as BI-RADS IV, 4 as a BI-RADS V lesion and unknown in 1 patient. *MRI-guided biopsy procedure and equipment* MRI-guided biopsies were performed on a 3-T clinical MR system (Achieva, Philips Medical Systems, Best, the Netherlands). Patients were placed in prone position in a dedicated phased-array bilateral breast coil with the affected breast in a dedicated breast coil with add-on biopsy device with a medial and lateral compression plate (figure 1) (MRI devices, Würzburg, Germany). The biopsy system comprises a guiding marker tube filled with a Gadolinium based solution that can be positioned in feet-head and anterior-posterior direction along a centimeter scale and angulated around the feet-head axis from +45° to -45° degrees. First, fat-suppressed high-resolution T1-weighted gradient echo images were acquired after the administration of 0.1 mmol/kg Gadolinium (Magnevist, Schering, Germany) to verify the position of the lesion. After correct positioning of the marker tube, the table top was moved out of the bore and local anesthesia (lidocaine 1%) was administered subcutaneously. The marker tube was replaced by a 14-gauge sterile biopsy needle surrounded by a 13-gauge needle holder (Somatex, Teltow, Germany). The needle and sheath were horizontally inserted in the breast and advanced towards the lesion. The position of the needle and sheath were confirmed by using the transverse 3D fat-suppressed high resolution T1-weighted gradient echo sequence. Scan parameters were chosen to minimize the artifact of the needle: echo time was set as short as possible, a small voxel size was chosen and the read-out direction was set parallel to the length of the needle. The main scan parameters of this sequence are listed in table 1. After correct placement of the biopsy needle was confirmed, the 14-gauge biopsy gun (Somatex, Teltow, Germany) was inserted through the sheath and the tissue samples were obtained. *Data Collection* Histopathological analysis of the lesions was performed and lesions were classified in two categories: benign or malignant. In case of a benign lesion, the images of the biopsy procedure were re-evaluated to determine whether the tissue samples were representative. If the samples were considered not representative, a second biopsy or surgical excision was performed, based on the level of suspicion of malignancy and patients' preferences. Follow-up information was collected from all patients. Malignant lesions were surgically removed.

	Biopsy scan protocol
TE (msec);TR (msec); flip angle	1.7 ; 4.5 ; 10 º
Fat suppression	Waterselective excitation pulse(PROSET)
Field of View (mm^2)	340 x 340
Acquired matrix	256 x 320
Reconstructed matrix	320 x 320
Read-out bandwidth (Hz)	1443
Direction read-out gradient	Perpendicular to B_0
Effective slice thickness (mm)	2 (overcontiguous slices)
Number of slices	75
Acquired voxel size (mm^3)	1.33 x 1.06 x 2.00
Reconstructed voxel size (mm^3)	1.06 x 1.06 x 1.00
Scan duration	86 seconds

Results

In two cases, MRI-guided biopsy was not feasible: in one patient a 9-mm lesions was located directly posterior to the mammilla and in another patient a 9-mm lesion was located directly anterior to the thoracic wall. In the other 28 patients with 29 lesions, the 3-T MRI-guided large core-needle biopsy was considered to be technically successful. The size of the needle artifact was 9.5 mm (figure 3). None of the procedures had to be interrupted or stopped. No severe side effects were observed. The 'MRI-only' lesion size ranged from 3 to 45 mm with a median lesion size of 9 mm. Histopathologic analysis of the biopsy samples resulted in 19/29 (66%) benign lesions (2 fibroadenoma, 3 fibrocystic change, 6 hyperplasia/ a denosis, 5 normal fibroglandular tissue, 1 intramammary lymph node, 1 lobular carcinoma in situ and 1 papilloma). The results of one biopsy procedure were inconclusive (1/29, 3%). This lesion was surgically removed, histopathological analysis showed no malignancy. Follow-up was heterogeneous due to large number of referring hospitals. In summary, follow-up of the 20 non-malignant biopsies showed no malignancy in 14 cases and revealed 2 malignant lesions: one LCIS lesion was surgically removed 1 month after the biopsy and additional DCIS and a small invasive ductal component were demonstrated during pathological analysis of the lump. The second case showed a more malignant kinetic enhancement curve at 12 month follow-up MRI. The lesion was sampled again and pathology showed an invasive lobular carcinoma. No follow-up information was available in 4 patients. Nine lesions 9/29 (31%) showed a malignant pathology result of the sampled tissue: 2 ductal carcinoma in situ, 2 invasive lobular carcinoma (apart from the lesion described above), 2 invasive ductal carcinoma and 3 adenocarcinoma. All malignant lesions were surgically removed: modified radical mastectomy (n=3), breast conserving surgery (n=3), unknown type of surgery (n=3).

Conclusion

MRI-guided biopsy at 3T is a safe and effective method for breast biopsy in lesions that are occult on mammography and ultrasound. The size of the needle artifact did not hamper the biopsy procedure. Follow-up MRI at 6 months after the biopsy should be performed in case of a benign biopsy result.

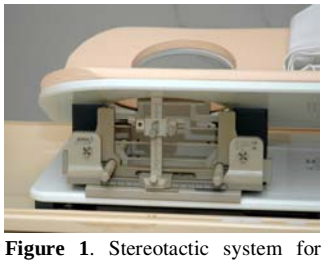

Figure 1. Stereotactic system for MRI-guided preoperative wire-localization and breast biopsy

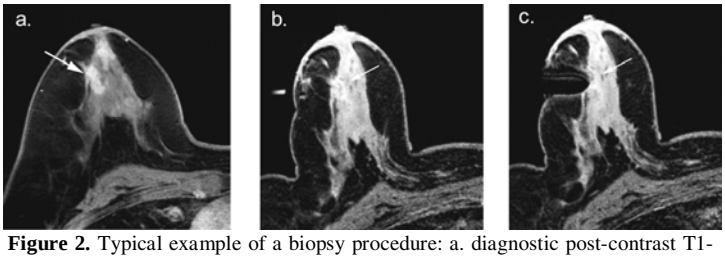

Figure 2. Typical example of a biopsy procedure: a. diagnostic post-contrast T1-weighted image shows suspicious lesion. b. pre-biopsy image, compressed breast with guiding marker tube at the same location as lesion. c. needle is inserted in front of the lesion, 4 samples were obtained. Histology: DCIS