MRI-guided Needle Localization for Breast Lesions Occult in Mammograms and Ultrasound

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To evaluate the diagnostic efficacy of breast magnetic resonance imaging (MRI)-guided needle localization and surgical biopsy for suspicious breast lesions occult on physical breast examination, mammography and second-look ultrasound.

Twelve patients (age range, 29-68 years; mean 44.9±9.24 years) received breast MR-guided needle localization and surgical biopsy for the suspicious lesions detected by breast MRI only. All procedures were successfully performed in a 1.5T MR system equipped with dedicated breast biopsy system. Eleven of the patients received lateral approach and one received medial approach with a 20-gauge MR-compatible localization needle. Contrast enhancement was given before or after deployment of the hookwire to confirm the location of the hookwire and the suspicious breast lesion.

The size of breast lesions ranged from 0.6 to 5 cm (mean±SD, 1.44±1.29cm). Final pathologic diagnoses from surgical specimens included two low grade ductal carcinoma in situ (16.7%). There were three lesions (25%) diagnosed as pre-malignant or high risk lesions, including 1 lobular carcinoma in situ (LCIS) and atypical ductal hyperplasia (ADH), 1 atypical lobular hyperplasia (ALH) and papilloma, and 1 ADH. Seven lesions (58.3%) were benign fibrocystic change (n=5), fibroadenomatous change (n=1) and an intraductal papilloma (n=1). There was no procedure-related complication. No definite abnormality was found in specimen mammograms in seven patients.

MRI-guided needle localization of breast lesions provides a confident approach for suspicious lesions detected only on MRI which cannot be biopsied under ultrasound or mammography guidance.

Mammography is the standard technique used in the screening and diagnosis of breast cancer and often supplemented by breast ultrasound. In recent years, breast magnetic resonance (MR) imaging is widely used in preoperative assessment of breast cancers, detection of synchronous or occult cancers, screening of women with high risk factors, monitoring the neoadjuvant chemotherapy response of breast cancer and as a problem solving complementary examination. Although breast MR imaging (MRI) is more sensitive than mammography, it has been shown to be less specific than mammography [1]. With the increasing role of breast MRI in the clinical setting, the requirement of MRI-guided tissue proof is increasingly in demand. Tissue proof of MRI-detected lesions of indeterminate or suspicious nature is important because the result of these MR findings may change therapeutic planning [2].

Breast MRI-guided needle localization provides an easy, safe, and quick solution for the nonpalpable suspicious lesions that are detected only by breast MRI while occult on both mammography and ultrasound, but some challenges still exist. The enhancing lesions will fade out after contrast injection due to contrast washout of the target lesions and wash-in of the adjacent parenchyma. Lateral approach is technically easier than medial approach with most of the

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commercially available equipments [3]. According to our knowledge, most of the literature of MRI-guided needle localization has been reported in Western countries [4-6]. The purpose of this study is to evaluate the result of breast MRI-guided needle localization on mammographically and ultrasonographically occult lesions in Taiwanese women.

**MATERIALS AND METHODS**

**Patient selection**

From August 2006 to May 2007, a total of 105 patients received breast MRI study in our breast center. Twelve people among those 105 patients received breast MRI-guided needle localization for surgical biopsy in our institution due to clinically nonpalpable, mammographically and sonographically occult, but MRI suspicious lesions. The inclusion criteria of MRI-guided needle localization were: (a) women with suspicious lesions detected by breast MRI only, but were not palpable and not seen in other breast imaging studies; and (b) women with suspicious lesions which could not be correlated with both mammography and second look ultrasound. Patients with lesions that could be identified and biopsied under mammographic or ultrasonographic guidance were excluded from MRI-guided needle localization procedures. The indications for initial diagnostic breast MRI were: problem solving MRI for questionable mammographic or ultrasonographic findings (n=4), previous free silicone injection (n=1), high risk patients with history of atypical ductal hyperplasia (n=1), preoperative evaluation of synchronous carcinoma (n=3), postoperative follow up of occult lobular carcinoma (n=1), contralateral ductal carcinoma in situ (DCIS) with ipsilateral lymph nodes (n=1) and abnormal screening breast MRI for health examination referred from other hospital (n=1).

**Equipments and protocols**

The initial diagnostic breast MRI examinations were performed with patients lying prone in a 1.5T MRI system (Signa Excite HD, GE Healthcare, Milwaukee, USA) using a dedicated surface breast coil. Rapid bolus injection of 0.2 mmol/L/kg of gadodiamide (Omniscan, GE Healthcare, Milwaukee, USA) was given for axial dynamic FSPGR (fast spoiled gradient echo) VIBRANT (volume imaging for breast assessment) sequence after pre-contrast axial T1-weighted sequence and sagittal fat-suppressed T2-weighted sequence. The parameters of VIBRANT sequences included 2-3 mm slice thickness without gap and 3.3 / 1.56 / 12° / 256 × 192 (TR / TE / flip angle / spatial resolution). The acquisition time of each dynamic scan was between 12 and 15 seconds depending on the volume coverage. A total of 36 phases of dynamic scans were acquired for the evaluation of kinetic curve. The interpretation of MR detected lesions was made according to the guidelines from the Göttingen score criteria using both morphologic and kinetic information [7].

All MR-guided needle localization was performed within 4 hours before surgical biopsy on the same day. The interventional MRI-guided localization procedures were performed with the patient prone or prone oblique in the same MRI machine using commercially available mediolateral or lateromedial direction compression plates and cross-hatched grid (GE Healthcare, Milwaukee, USA) for immobilization. A fish oil capsule was placed in the grid hole as a reference point for the target lesion. The localization sequence was T1-weighted or fat-suppressed T2-weighted sequence according to the visibility of the lesion on different pulse sequences on the initial diagnostic MRI. Hand bolus of 0.1 mmol/L/kg of gadodiamide was given for the sagittal contrast enhanced T1-weighted sequence to determine the location and depth of the lesions. 20-Guage MRI-compatible needles and hookwires (MRI-compatible lesion marking system, E-Z-EM, Westbury, NY, USA) in 5, 7.5 or 10cm length were used after local anesthesia. After making deploying of the hookwire, another 0.1 mmol/L/kg of gadodiamide was given to confirm the position of localization needle and hookwire.

**RESULTS**

MRI-guided needle localization was successfully performed at twelve lesions in twelve women between the ages of 29-68 years (mean ± SD, 44.9 ± 9.24 years). The size of the 12 lesions detected by initial breast MRI ranged from 0.6 to 5.0cm (mean ± SD, 1.44 ± 1.29 cm) and the size of all lesions were unchanged on the day of localization. All the lesions were single and unilateral with five lesions (41.7%) located in the left breast and seven (58.3%) located in the right breast. Access via lateral approach was used in eleven cases (91.7%) with lesions in the outer or central part of the breast and medial approach in one case (8.3%) with the lesion in the medial part.
A 46-year old patient with past history of invasive lobular carcinoma. (A) A newly developed irregular segmental enhancement (open arrow) on contrast-enhanced axial T1-weighted image at the right inner breast which is associated with diffuse skin thickening due to prior radiation therapy. (B) MRI-guided needle localization is successfully performed with the wire (arrow) at the edge of the suspicious enhancement (circle) on sagittal T1-weighted image. This lesion proved to be fibrocystic change on the resected surgical specimen. (C) Follow-up study shows complete removal of the prior suspected lesion and a seroma (arrowhead) at the surgical site associated with rim enhancement on axial T1-weighted image three months later.
of a definitive surgical resection due to the large size of the suspicious lesion (Fig. 2). The overall successful rate of MRI-guided needle localization was 100% (12/12).

**DISCUSSION**

Breast MRI has an increasing role in the detection and evaluation of breast cancers in recent years, especially for high-risk population [1]. The indications of breast MRI include detection of ipsilateral or contralateral synchronous breast carcinomas [8, 9], preoperative assessment of disease extent [10], postoperative assessment of residual disease [11], monitoring of the response to neoadjuvant chemotherapy [12, 13], screening of high risk population groups [1, 14], evaluation of surgically altered breasts (such as augmentation or breast conserving therapy), searching for occult breast cancers, and problem solving in women with questionable findings detected on other breast imaging studies [11].

Due to the relatively lower specificity [1], tissue diagnosis is crucial before wide excision or changes are made to the treatment plan of suspicious lesions detected on breast MRI. Recently, there is increasing usage of breast MRI as an adjuvant tool in Taiwan. Therefore, MR-guided needle localization or biopsy of breast lesions are increasingly in demand.

Although MRI-guide needle localization is a quick, safe and easy procedure, some technical difficulties can be encountered. For example, in patients with a suspicious lesion close to the outer chest wall, a prone oblique position may be necessary for easier needle positioning (Fig. 3). Causer PA et al has reported needle placement errors associated with small lesions, fatty breasts and tissue shift in the z
plane [3]. To minimize the accordion effect of breast tissue, compression of the breast should be appropriately applied; and overly tight compression will also compromise the enhancement of the target lesion.

A 5-10.3% cancellation rate has been reported on the day of the scheduled procedure due to nonvisualization of the lesion [6, 15]. This does not come as a surprise for us, therefore patients need to be well informed of this possibility [16]. Complications such as retained or breakage of the wire has been reported [6] which was not encountered in our preliminary experiences. Compared with the procedure time of 15-59 minutes reported by Morris et al. [6], our procedure time of 30-80 minutes is relatively longer because of the initial learning curve and limited experience. The positive predictive value (PPV) of nonpalpable, mammographically occult, MRI-detected breast lesions was reported as being 20.4-30.7% [4, 6, 17]. The PPV increases as lesion size increases. In lesions smaller than 5mm, the PPV is 3% in a large series of 606 cases reported by Liberman L et al. [4]. It has been shown that ultrasonic correlation can influence the positive rate for MR-guided breast needle localization. The positive rate for malignancy was higher in patients that did not receive ultrasonic correlation than those who had ultrasonic correlation (43% vs. 14%) according to the report by LaTrenta LR et al. [17]. Our lower frequency of cancer (16.7%) is related to patient selection and the use of second look breast ultrasound which may detect many mammographically occult breast lesions. After excluding ultrasonic correlated lesions, our result (16.7%) had a comparable detection rate of malignancy as that shown by LaTrenta LR et al. (14%) [17]. Specimen mammography was reported to be valuable in the confirmation of MRI-guided needle localization and surgical excision with 42% abnormality in whole-specimen assessment and 82% abnormality in sliced-specimen radiography in a study of 12 lesions [18]. However, we did not find whole-specimen mammograms to be of great value. This may be attributed to the small number of patients in this study, patient selection bias or a lower cancer incidence in Taiwan as compared with Western countries. Further investigation and analysis with larger number of patients who receive MR-guided needle localization for suspected breast lesion may be required to resolve this issue.

Due to the low positive rate and high cost of MRI-guided needle localization and surgical excision, the decision of tissue proof should be made cautiously. Well understanding of the possible false positive findings could help us to avoid unnecessary biopsies. The common causes of false positives include hormone-related enhancement, focal fibrosis, post-operative changes, fat necrosis, fibroadenomas, fibrocystic changes, intraductal papilloma, and intramammary lymph nodes [19]. The hormone related enhancement is aggravated at the first and fourth weeks of menstrual cycle but less obvious at the second week of cycle. The breast MRI examination should best be performed between day 7 and 14 of the menstrual cycle or two to three months after ceasing of hormone replacement therapy to avoid the interference on MRI interpretation [11]. Lymph nodes and papillomas typically show rapid upslope and washout kinetic curves, however, lymph nodes can be easily identified by their typical morphology, fatty hila, typical locations and high signal intensity on T2-weighted image [20]. Post-operative changes and fat necrosis could be suspected if there is sufficient clinical information. A washout kinetic curve might be incorrectly drawn due to imperfect patient immobilization, especially in small lesions. Lesion migration out of the region of interest (ROI) would result in a fake washout curve. Therefore it is very important to check the exact locations of enhancing lesions on each dynamic time point. Huang W et al. reported the combination of dynamic contrast enhanced images, 1H MR spectroscopy and perfusion MRI improve the specificity of breast MRI [21]. To improve specificity, breast MRI should be interpreted by highly experienced experts who are familiar with MRI, mammography and breast ultrasound [20].

Choosing MRI-guided vacuum-assisted core biopsy instead of needle localization in proper circumstances could decrease the need for repeated surgery if the percutaneous biopsy is technically feasible. MRI-guided vacuum-assisted core biopsy is more valuable in those patients with highly suspicious lesions or lesions of low suspicion. In the highly suspicious group, once malignancies are proven via MRI-guided vacuum-assisted core biopsy, patients could undergo wide excision with axillary lymph node dissection or sentinel lymph node biopsy at the same time. A definite operation can be performed in one attempt. MRI-guided vacuum-assisted core biopsies are also of benefit to patients with low suspicious lesions due to a decrease in benign operations. Patients with multifocal lesions, moderate concern lesions or lesions very close to chest wall might benefit from MRI-guided needle localization and surgical biopsy due to larger amounts of specimen...
obtained and increased confidence of biopsy result and safety concern.

**CONCLUSION**

MRI-guided breast needle localization is a safe, easy and quick procedure with increasing importance after wider clinical application of breast MRI. Careful patient selection is necessary because of the low positive predictive value and high expenses associated with this procedure.

**REFERENCES**

以乳房磁振造影指引之細針定位術化驗乳房攝影及乳房超音波無異常之病灶

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評估對於在理學檢查、乳房攝影及乳房超音波檢查皆無異狀，但在乳房磁振造影 (MRI) 檢查上卻有懷疑的病灶，使用乳房磁振造影指引之細針定位及手術切片化驗的準確性與可行性。

總共有 12 位病灶只能被乳房磁振造影所偵測到的病人（年齡 29~68 歲；44.9 ± 9.24 歲）成功地接受乳房磁振造影指引之細針定位及手術切片，過程皆使用 1.5T MRI 機器、乳房切片專用的配備及與 MRI 相容之定位細針。其中 11 位病人由外側入針，1 位由內側入針，在置放定位細針之前及之後，皆注射顯影劑以確認正確位置。

病灶大小為 0.6~5 公分 (1.44 ± 1.29 公分)。其中，2 例 (16.7%) 為原位癌，3 例 (25%) 為癌前或高危險病灶，包含一例 lobular carcinoma in situ 合併 atypical ductal hyperplasia (ADH)、一例 atypical lobular hyperplasia 合併乳突瘜及一例 ADH，7 例 (58.3%) 為良性病灶。此 12 例定位檢查，並無造成任何併發症。

對於在乳房攝影及乳房超音波檢查下無異狀，但乳房磁振造影 (MRI) 上卻有懷疑的病灶，乳房磁振造影指引之細針定位提供一安全、迅速、準確的切片化驗方式。