The cancer rate with the characteristics of such groups and estimated the biopsy yield in a general practice population. The purpose of our study was to investigate the outcome of MRI-guided breast biopsy as a function of the indication for MRI and the MRI features of the lesions.

Materials and Methods

Patients and Lesions

The institutional review board approved this study. We retrospectively reviewed the data for 172 MRI-detected breast lesions in 154 consecutive women who were scheduled to undergo MRI-guided vacuum-assisted biopsy (VAB) at our institution during the year 2005. The mean age of the study group was 51 years (range, 30–83 years). MRI-guided VAB was recommended on the basis of a clinical need for pathologic verification of MRI-detected lesions. Sonography performed before biopsy failed to reveal a

Breast MRI has a high sensitivity of 86–100% and a variable specificity of 20–100% for the detection of breast cancer [1–5]. There is a large overlap in the MRI findings of enhancing breast lesions, which often makes decisions regarding patient management difficult. Therefore, tissue diagnosis is gaining popularity [6–8]. Considering that MRI-detected lesions are not always detectable using other conventional imaging techniques such as mammography and sonography, it seems necessary to perform a biopsy that is guided by MRI [7, 9].

The cancer rate of patients who undergo MRI-guided breast biopsy has been reported to range from 20% to 61% depending on the study design and population [6–14]. Although it is predictable that this variability comes from differences between cohort groups with certain characteristics, to our knowledge, no detailed study has compared

Objective. The objective of our study was to investigate the outcome of MRI-guided breast biopsy as a function of the indication for MRI and the MRI features of the lesions.

Materials and Methods. In 154 women (mean age, 51 years) with 172 MRI-detected lesions, MRI-guided vacuum-assisted breast biopsy was attempted. Using the original radiologic report, we evaluated the indication for the original MRI examination and the MRI findings that led to biopsy. We investigated the core and operative histology results and follow-up data. We analyzed the cancer rate as a function of the indication for MRI and the MRI features of the lesions using Fisher’s exact test.

Results. In 22 of the 172 lesions (13%), MRI-guided biopsy was deferred due to decreased visualization or nonvisualization of the MRI finding that led to biopsy. Of 150 biopsies in 134 women, core histology revealed 39 malignant (39/150, 26%), 90 benign (90/150, 60%), and 21 high-risk (21/150, 14%) lesions. Through operative histology (n = 13) or follow-up (n = 30), four high-risk lesions were upgraded to malignancy and all deferred lesions except four lost to follow-up were confirmed to be benign. The final number of malignancies was 43 (29%) including 16 in situ and 27 invasive cancers. The probability of malignancy was different in the screening and diagnostic settings (14% vs 36%, respectively; p = 0.05), whereas it was not different according to lesion type (mass, 34%; nonmass, 27%; focus, 19%; p > 0.05) or kinetics (persistent, 23%; plateau, 31%; washout, 29%; p > 0.05).

Conclusion. The cancer rate in our cohort of women who underwent MRI-guided breast biopsy was 29%. It varied according to the indication for the original MRI examination, but not according to the MRI features of the lesions.

Keywords: breast biopsy, breast neoplasms, diagnostic imaging, MRI-guided biopsy, vacuum-assisted biopsy

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sonographic correlate in 51 patients and sonography and MRI findings were discordant in five others, leading to a recommendation of MRI-guided biopsy; in the other patients, sonography was not performed according to patient preference or at the discretion of the radiologist or clinician when the possibility of identifying a sonographic lesion was presumed to be very low. Because this study was a review of patients who underwent MRI-guided biopsy, we cannot provide data related to patients who underwent sonographically guided biopsy for correlative findings.

**MRI Findings Before Biopsy**

Except the MRI examinations of 50 women who underwent MRI at another institution, breast MRI was performed using a 1.5-T system (Siemens, GE Healthcare; or Symphony, Siemens Medical Solutions) with the patient lying in a prone position and each breast compressed gently between medial and lateral plates. Sequences included sagittal T1-weighted spin-echo (TR/TE, 500/14), sagittal T2-weighted fat-suppressed fast spin-echo (4,000/120), and sagittal dynamic contrast-enhanced imaging before and after injection of contrast material. Contrast material (gadopentetate dimeglumine [Magnevist, Bayer Schering Pharma]) was injected as a 20-mL IV bolus and was followed by a saline flush. The dynamic contrast-enhanced images included three contrast-enhanced images obtained with a 3D T1-weighted fat-suppressed fast spoiled gradient-echo sequence (minimum TR/minimum TE; flip angle, 30–90°; thin sections [2–3 mm with no intersection gap]; acquisition time, 97 seconds).

The images were interpreted by one of 10 radiologists including three of the authors. The BI-RADS MRI lexicon [15] was used. The MRI-Guided Biopsy

Informed consent was obtained. Imaging was performed with all patients in a prone position using a dedicated breast compression coil after injection of contrast material. One of the three author radiologists who specialize in breast MRI reviewed the images and decided whether the biopsy should continue. When the target lesion was not visualized or appeared to have decreased in size, biopsy was deferred at the discretion of the radiologist. For the patients whose biopsies were deferred, follow-up in 6 months was recommended.

For the biopsies, we used a dedicated breast compression coil fitted with a sterile perforated plate and two reference markers containing copper sulfate to be placed in arbitrary holes in the plate. We calculated the coordinates (superior to inferior, anterior to posterior, and right to left) of the enhancing lesion by measuring the distance between the nearest reference marker and the lesion without special software for an MRI-guided intervention. Biopsies were performed using a 9- or 10-gauge vacuum-assisted needle and a biopsy system (ATEC, Bard Surgical Systems; or Vacora, Bard Biopsy Systems). Four to 10 core samples were obtained.

The breast MRI sequences included axial, sagittal, and coronal T1-weighted localizing sequences followed by a fat-suppressed 3D spoiled gradient-echo sequence (minimum TR/minimum TE, 3-mm section thickness, 512 x 256 imaging matrix, acquisition time of 97 seconds) performed before and after IV administration of 20 mL of gadodiamide (Omniscan, GE Healthcare) plus 10 mL of saline. During and after biopsy, MRI was performed in the sagittal and transverse planes to confirm the location of the needle and to identify postbiopsy changes. A titanium clip (MammMark Biopsy Site Marker, Artemis Medical) was placed at the biopsy site in 137 lesions. In 13 lesions, clip placement was skipped because of patient preference or at the discretion of the radiologist performing the biopsy on the basis of his or her judgment that the lesion was almost definitely malignant enough to convert to a mastectomy rather than breast-conserving surgery or that the suspicion for malignancy was low. When a clip was placed, scanning was repeated for clip identification.

**MRI Indications, Diagnostic Procedure, Management, and Follow-Up**

The indications for MRI were classified into a screening setting and a diagnostic setting: screening in asymptomatic women with or without a personal history of breast cancer whose risk factors for breast cancer were identifiable in most cases (n = 49) or diagnostic in women with a recently diagnosed cancer undergoing evaluation of the extent or presence of cancers in the ipsilateral or contralateral breast and in women with an unsolved palpable, clinical, or mammographic abnormality (n = 92). If MRI abnormalities were found when MRI was performed to evaluate an indistinct palpable area and sonography before or after MRI showed normal findings or findings not concordant with MRI (i.e., location, size, or architecture of MRI and sonographic findings differed) so that sonographic guidance was not considered clinically appropriate to establish a pathologic diagnosis, MRI-guided VAB was performed. If there were incidental MRI findings when MRI was performed to evaluate mammographic lesions and they were not diagnosed with additional mammography or sonography, MRI-guided VAB was performed. In addition, in cases in which MRI was performed to evaluate mammographic findings or mammography guidance was technically difficult because of lesion visualization in a single view or lesion location, MRI-guided VAB was performed.

All MRI reports included an addendum to ensure imaging–histologic concordance and to recommend the next step after histologic diagnosis of MRI-guided VAB by the original reader. Surgical follow-up was recommended for all malignant lesions, all high-risk lesions (i.e., atypical ductal hyperplasia, atypical lobular hyperplasia, atypical papillary lesions, radial scar, and lobular carcinoma in situ), and all benign results that were discordant with MRI findings. On retrospective evaluation of imaging findings and histology results, if the MRI-guided VAB result was benign and imaging performed immediately after biopsy showed a cavity that unequivocally included the area of highest suspicion [16], MRI follow-up was not routinely recommended. Although the reference standard was operative biopsy findings for malignant lesions, we also used malignant core biopsy results after final operative histology results as a reference standard. Thirty-two of the 39 malignant lesions, 16 of the 21 high-risk lesions, and five of the 90 benign lesions were confirmed by surgical biopsy. MRI or mammographic follow-up data were available in four of the 21 high-risk lesions and 32 of the 90 benign lesions.

**Data Collection and Analysis**

Medical records were reviewed for patient age, the indication for MRI, and histopathologic and radiologic results. Histopathologic results were examined on the basis of pathologic reports of MRI-guided VAB and subsequent surgical biopsy. All pathology results were interpreted according to the clinical routine used at our institution, which includes review by a pathologist with a subspecialty focus in breast pathology. The MRI features of the lesions before biopsy were recorded from the original report. Descriptors other than the exact language in the BI-RADS MRI lexicon [15] were mapped to lexicon descriptors: a “nodule” to a “mass”; and a “lesion” or an “area” to a “nonmass.”

Foci larger than 5 mm and foci with a nonsmooth margin were reclassified as masses. Accordingly, a lesion type of focus meant a lesion smaller than 5 mm with a smooth margin. Imaging features included lesion size; type (focus, mass, or nonmass); morphologic features—that is, margin of mass (smooth or nonsmooth) or distribution of nonmass (regional, segmental, linear ductal, or focal area); and kinetic features (persistent, plateau, or washout). For cases in which one of the features was missing on the original report (lesion type, n = 7; margin or distribution, n = 54; kinetic feature,
of the authors retrospectively reviewed the images and analyzed those findings in a blinded fashion.

**Statistical Analysis**

The probability of malignancy for an MRI abnormality was calculated as the ratio between the number of lesions with pathologically proven malignancy (ductal carcinoma in situ and invasive cancers) and the number of biopsied lesions. For benign lesions, we used 12-month MRI or mammographic follow-up as the reference standard. We investigated the probability of malignancy for MRI abnormalities according to the indication for MRI and the MRI features of the lesions and compared the probabilities using Fisher’s exact test.

**Results**

**Biopsy Procedure, Core Histology Result, and Final Result**

Biopsy was deferred in 20 women with 22 lesions because of nonvisualization of the MRI finding that led to the biopsy recommendation and was technically successful in the remaining 134 women with 150 lesions. There were no major complications.

Of the 150 lesions biopsied in 134 women, 39 (26%) were malignant lesions (ductal carcinoma in situ, 15; invasive ductal cancer, 15; invasive lobular cancer, 5; mixed invasive ductal and lobular cancer, 3; tubular cancer, 1); 90 (60%) were benign lesions, and 21 (14%) were high-risk lesions. The probability of malignancy for an MRI abnormality was 29% (43/150).

The probability of malignancy in the screening setting (35%) (in women with a recently diagnosed breast cancer) was significantly lower than that in the diagnostic setting (36%) (in women with a symptom or symptoms, imaging abnormality, or known breast cancer) (p = 0.05). An MRI abnormality detected during workup for search of additional cancer in women with recently diagnosed breast cancer showed a malignancy rate of 37% and the malignancy rate was 43% (9/21) in the ipsilateral breast and 30% (6/20) in the contralateral breast. When a woman underwent MRI for additional screening for breast cancer, if she had personal history of breast cancer, the probability of malignancy was 23%; if not, it was 7%.

**Indication for MRI**

Excluding nine lesions in seven patients who underwent MRI at another institution and whose reasons for undergoing breast MRI were not apparent from the records available, the indication for MRI and the specific reason for biopsy were identified in the original reports for 141 lesions in 127 patients (Table 2). When multiple lesions were biopsied in a single patient, the reasons for biopsy could differ for each lesion. The common indications of MRI that led to MRI-guided VAB were for evaluation of women with a recently diagnosed breast cancer (n = 41, 29%) and for screening in asymptomatic women at high risk without a personal history of breast cancer (n = 27, 19%).

The probability of malignancy in the screening setting (14%) (in asymptomatic women) was significantly lower than that in the diagnostic setting (36%) (in women with a symptom or symptoms, imaging abnormality, or known breast cancer) (p = 0.05). An MRI abnormality detected during workup for search of additional cancer in women with recently diagnosed breast cancer showed a malignancy rate of 37% and the malignancy rate was 43% (9/21) in the ipsilateral breast and 30% (6/20) in the contralateral breast. When a woman underwent MRI for additional screening for breast cancer, if she had personal history of breast cancer, the probability of malignancy was 23%; if not, it was 7%.

**MRI Features of the Lesions and the Probability of Malignancy**

Lesion diameters ranged from 4 to 70 mm (mean, 15 mm). The MRI features of the lesions and the probabilities of malignancy according
Outcome of MRI-Guided Breast Biopsy

TABLE 3: MRI Findings of 150 Targeted Lesions and the Probability of Malignancy

<table>
<thead>
<tr>
<th>Features</th>
<th>No. of Lesions/Total No. of Lesions (%)</th>
<th>No. of Malignant Lesions/No. of Lesions (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lesion type</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Focusa</td>
<td>21/150 (14)</td>
<td>4/21 (19)</td>
</tr>
<tr>
<td>Massb</td>
<td>61/150 (41)</td>
<td>21/61 (34)</td>
</tr>
<tr>
<td>Nonmassc</td>
<td>68/150 (45)</td>
<td>18/68 (27)</td>
</tr>
<tr>
<td>Total</td>
<td>150/150 (100)</td>
<td>43/150 (29)</td>
</tr>
<tr>
<td>Morphology</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Margin of mass</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Smooth</td>
<td>23/150 (15)</td>
<td>5/23 (22)</td>
</tr>
<tr>
<td>Nonsmooth</td>
<td>35/150 (23)</td>
<td>15/35 (43)</td>
</tr>
<tr>
<td>Distribution of nonmass</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Regional</td>
<td>18/150 (12)</td>
<td>5/18 (28)</td>
</tr>
<tr>
<td>Segmental</td>
<td>10/150 (7)</td>
<td>3/10 (30)</td>
</tr>
<tr>
<td>Linear ductal</td>
<td>19/150 (13)</td>
<td>5/19 (26)</td>
</tr>
<tr>
<td>Focal areas</td>
<td>21/150 (14)</td>
<td>5/21 (24)</td>
</tr>
<tr>
<td>Undescribed</td>
<td>3/150 (2)</td>
<td>1/3 (33)</td>
</tr>
<tr>
<td>Total</td>
<td>129/150 (86)</td>
<td>39/129 (30)</td>
</tr>
<tr>
<td>Kinetic feature</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Persistent</td>
<td>66/150 (44)</td>
<td>15/66 (23)</td>
</tr>
<tr>
<td>Plateau</td>
<td>36/150 (24)</td>
<td>11/36 (31)</td>
</tr>
<tr>
<td>Washout</td>
<td>17/150 (11)</td>
<td>5/17 (29)</td>
</tr>
<tr>
<td>Undescribed</td>
<td>31/150 (21)</td>
<td>12/31 (39)</td>
</tr>
<tr>
<td>Total</td>
<td>150/150 (100)</td>
<td>43/150 (29)</td>
</tr>
</tbody>
</table>

aSize, 4–5 mm; mean, 4.9 mm.
bSize, 6–32 mm; mean, 12.7 mm.
cSize, 6–70 mm; mean, 22.4 mm.

to lesion features are summarized in Table 3. The probability of malignancy was 34% (21/61) for masses (Figs. 1 and 2), 27% (18/68) for nonmasses (Figs. 3 and 4), and 19% (4/21) for foci (Figs. 5 and 6). The results of Fisher’s exact test showed no difference in the probability of malignancy according to lesion type (p = 0.37). Malignancy was found in 43% (15/35) of the nonsmooth masses (Fig. 1) and 22% (5/23) of the smooth masses (Fig. 2), but the difference was not statistically significant.

The probability of malignancy was higher in cases with plateau (31%, 11/36) or washout (29%, 5/17) kinetics than in those with persistent kinetics (15/66, 23%), but the difference was not statistically significant (p = 0.55). Malignancy was found in 19% (4/21) of foci but was absent in foci with persistent kinetics (Fig. 5). The probability of malignancy according to the distribution of nonmasses was similar among those that were segmental (30%, 3/10), regional (28%, 5/18), linear ductal (26%, 5/19), and a focal area pattern (24%, 5/21) (p = 0.97).

Combination of Each Descriptor Including Morphology and Kinetics

We calculated the probability of malignancy after combining morphologic and kinetic data for the lesions (Table 4). The probability of malignancy was lowest in lesions appearing as a focus with persistent (0%, 0/6) or washout (0%, 0/1) enhancement and it was highest in lesions appearing as a non-smooth mass with plateau enhancement.

Fig. 1—59-year-old woman who presented with axillary lymphadenopathy. Sagittal fat-suppressed 3D spoiled gradient-echo MR image in first phase after contrast administration shows 1.4-cm nonsmooth mass (arrow) with persistent enhancement kinetics in lower breast. MRI-guided vacuum-assisted biopsy revealed infiltrative ductal cancer.

Fig. 2—50-year-old woman with ipsilateral breast cancer. Sagittal subtracted image of fat-suppressed 3D spoiled gradient-echo MR image shows 1.8-cm smooth mass (arrow) with persistent enhancement kinetics, away from biopsy-proven cancer (not shown). MRI-guided vacuum-assisted biopsy revealed fibrocystic change and finding had not changed on follow-up MRI 1 year after biopsy.

Fig. 3—47-year-old woman with contralateral breast cancer. Sagittal subtracted image of fat-suppressed 3D spoiled gradient-echo MR image shows clumped regional nonmass enhancement (circle) with persistent enhancement kinetics. MRI-guided vacuum-assisted biopsy revealed ductal and lobular carcinoma in situ.
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(50%, 4/8), a nonsmooth mass with washout enhancement (50%, 1/2), or a smooth mass with washout enhancement (50%, 3/6).

However, no descriptor combinations tested showed a statistical difference in the probability of malignancy ($p = 0.462$).

**Biopsy-Deferred Lesions**

In 22 (12.8%) of the 172 lesions (20 [13.0%] of 154 women), MRI-guided VAB was deferred because the lesions showed decreased enhancement ($n = 14$) or were not visible ($n = 8$). Among those patients, two underwent MRI-guided VAB 6 months later because the lesions were seen then and appeared more prominently, but the results were benign. Follow-up MRI in 10 (45.5%) of the 22 deferred cases revealed that seven lesions had decreased in size and three had disappeared, resulting in the assignment of a benign pathologic diagnosis. An additional six patients underwent follow-up mammography that showed stable findings. The remaining four patients were lost to follow-up. The biopsy-deferred lesions were a focus in 10 cases, a mass in three, and a nonmass area in nine. The kinetics showed a persistent enhancement pattern in 20 and a plateau pattern in two.

**Discussion**

The results of this study show that the positive biopsy rate of MRI-guided VAB is different in the various clinical settings that lead to breast MRI examinations. We investigated the indication for the MRI examination that led to MRI-guided VAB. In this study, the cancer rate in the diagnostic setting (36%), in which women with breast cancer were referred for workup for search of additional cancers and women with a subtle lump, a mammographic abnormality, nipple discharge, or axillary lymphadenopathy were referred for evaluation, was significantly higher than the rate in the screening setting (14%) in women without a clinical or imaging abnormality.

In the ipsilateral breast of women with proven breast cancer, the cancer rate was 43% and was identical to that obtained in the study by Liberman et al. [2], who reported 19 cancers among 44 MRI-detected ipsilateral lesions in 77 breast cancer patients. In the contralateral breast of women with proven breast cancer, the cancer rate was 30% and was lower than that obtained by Lee et al. [1], who detected seven cancers (47%) among 15 contralateral lesions by MRI-guided or mammography-guided localization in their study of 182 breast cancer patients.

The convenience of MRI-guided biopsy compared with surgical excision after localization is the probable reason for the relatively low cancer rate in our study group by the inclusion of various MRI abnormalities. This lower cancer rate is a contrast to our initial experience with MRI-guided VAB in which the cancer rate for 85 lesions was 61% [7]; for

**TABLE 4: Probability of Malignancy of MRI-Guided Biopsied Lesions as a Function of Combined Morphologic and Kinetic Features**

<table>
<thead>
<tr>
<th>Morphology</th>
<th>Kinetics</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Focus</td>
<td>Persistent</td>
<td>0/6(0)</td>
</tr>
<tr>
<td></td>
<td>Plateau</td>
<td>2/9(22)</td>
</tr>
<tr>
<td></td>
<td>Washout</td>
<td>0/1(0)</td>
</tr>
<tr>
<td>Smooth mass</td>
<td>Persistent</td>
<td>1/8(13)</td>
</tr>
<tr>
<td></td>
<td>Plateau</td>
<td>1/6(17)</td>
</tr>
<tr>
<td></td>
<td>Washout</td>
<td>3/6(50)</td>
</tr>
<tr>
<td>Nonsmooth mass</td>
<td>Persistent</td>
<td>6/17(35)</td>
</tr>
<tr>
<td></td>
<td>Plateau</td>
<td>4/8(50)</td>
</tr>
<tr>
<td></td>
<td>Washout</td>
<td>1/2(50)</td>
</tr>
<tr>
<td>Nonmass</td>
<td>Persistent</td>
<td>8/35(23)</td>
</tr>
<tr>
<td></td>
<td>Plateau</td>
<td>4/13(31)</td>
</tr>
<tr>
<td></td>
<td>Washout</td>
<td>1/7(14)</td>
</tr>
<tr>
<td>Total</td>
<td>Persistent</td>
<td>15/66(23)</td>
</tr>
<tr>
<td></td>
<td>Plateau</td>
<td>11/36(31)</td>
</tr>
<tr>
<td></td>
<td>Washout</td>
<td>5/16(31)</td>
</tr>
</tbody>
</table>

Note—Data are number of lesions/total number of lesions (%).

Fig. 4—54-year-old woman with subtle mammographic asymmetry. Mammographic asymmetry was not seen as mass on sonography (not shown). Sagittal subtracted image of fat-suppressed 3D spoiled gradient-echo MR image shows focal area of nonmass enhancement (arrow) with persistent enhancement kinetics. MRI-guided vacuum-assisted biopsy revealed lobular carcinoma in situ. Operation performed after biopsy revealed fibrocystic change.

Fig. 5—54-year-old woman with ipsilateral breast cancer. Sagittal fat-suppressed 3D spoiled gradient-echo MR image in first phase after contrast administration shows 4-mm focus with plateau kinetics (short arrow) away from postoperative scar (long arrow). Pathologic diagnosis through MRI-guided vacuum-assisted biopsy was mixed invasive ductal and lobular cancer.

Fig. 6—78-year-old woman with ipsilateral breast cancer. Sagittal subtracted image of fat-suppressed 3D spoiled gradient-echo MR image shows 5-mm focus (arrow) with plateau kinetics away from biopsy-proven cancer (not shown). MRI-guided vacuum-assisted biopsy revealed benign breast tissue and follow-up MRI after definitive surgery showed no abnormal enhancement around this area.
that study, we strictly limited the target of MRI-guided VAB to cases with a high probability of malignancy in the initial phase of MRI-guided VAB. In the current study, we included 27 cases with an MRI abnormality detected during screening MRI in asymptomatic women without a personal history of breast cancer. Because we investigated only the cases for which MRI-guided VAB was performed, we do not know how frequently an MRI abnormality is seen or how many cancers are detected in women undergoing screening MRI because some cancers are verified by another biopsy method.

When an actionable MRI abnormality is detected, the cancer rate was similar regardless of the MRI features of the lesions. In this study, the overall malignancy rate was 29%. The results of most previous reports on MRI-guided biopsy showed similar malignancy rates of 20–27% [11–14]. A recent study of MRI in women at high risk for breast cancer showed a 43% positive predictive value for biopsies performed as a result of MRI findings [17]. This higher cancer yield may result from population differences. In addition, most of the patients in our series underwent mammography and sonography. MRI-guided VAB was clinically recommended only if lesions were not well visualized on the other imaging techniques or if the biopsy was technically difficult. These criteria increased the relative number of nonmass, subcentimeter mass, or focus cases that by their nature are not well shown by mammography or sonography.

In previous reports of pathologically documented MRI-detected lesions, the authors usually divided lesions into two groups: mass and nonmass lesions [9, 18]. We followed the guidelines of the BI-RADS MRI lexicon [15] for lesion type and found that our study group had three types of lesions. In contrast to other reports in which the biopsied targets were mainly spiculated or irregular masses, we also targeted a moderate number of cases of a focus (n = 21) and a smooth mass (n = 23), and the yielded cancer rate was 19% and 22%, respectively.

Focus lesions referred for biopsy generally showed intense enhancement, plateau, or washout kinetics. They occurred at the site where documentation of additional cancer might require a change of the surgery type in women with proven cancers or they were lesions that appeared newly or more prominently in the follow-up study of high-risk patients. Although the malignancy rate of a focus with persistent or washout kinetics was 0%, this result is based on too few cases (n = 6 and n = 1, respectively) and is not clinically relevant. A broad indication for biopsy reflects the increased need for pathologic verification and the preference of percutaneous biopsy to surgical biopsy.

We found a histologic underestimation rate of 25% in high-risk lesions, similar to other reports on MRI-guided biopsy [11, 13, 19], which is relatively higher than that of stereotactic biopsy. This underestimation rate has been explained by the population composed of a high-risk group and the characteristics of the target lesions that were usually small or heterogeneous and noncontiguous [19].

In 14% of the patients in our study, biopsy was deferred on the scheduled day because of lesion absence (n = 8) or decreased visualization (n = 14). Strong breast compression during the biopsy might influence visualization of the lesions. Eleven women with 12 lesions underwent 6-month follow-up imaging without breast compression. Two lesions were seen again and eventually were verified as benign. The other possible reason lesions were difficult to see or were not seen is hormonal change. Although Vielweg et al. [16] reported biopsy-deferred cases in women with a recent history of hormone replacement therapy or in perimenopausal women, we did not correlate patient hormonal status and MR visualization of a lesion. It would be better to obtain a history of menstrual cycle and hormone replacement therapy before imaging. Because there have been reports of missed cancers among MRI-guided biopsy-deferred cases [20], we believe that special care should be taken in the management of deferred cases. Although we recommended follow-up in all deferred cases, four of the 20 patients in our study were lost to follow-up.

Our study has several limitations. Because this study is retrospective, the lesion descriptions, particularly the distribution modifiers of nonmass, often were not specified or did not use terms from the BI-RADS MRI lexicon. We modified them to descriptions that fit for the best lexicons as possible. Also, in the 50 patients who underwent MRI before biopsy at an outside hospital, the quality of the images was not always good enough to analyze morphologic and kinetic features (n = 32) or only the reports were available (n = 18). An additional limitation is incomplete follow-up of several cases that showed discordant findings, high-risk or borderline pathologic diagnosis, and biopsy deferral. An effort for thorough follow-up was requested and could have influenced some of the results of this study.

In conclusion, the cancer rate of women who underwent MRI-guided VAB was 29% in our cohort. It was different according to the indication for the original MRI examination and it was higher in the diagnostic setting (i.e., in women with symptoms, an imaging abnormality, or known cancer) than in the screening setting (i.e., in asymptomatic women). Although the morphologic pattern of a focus, a smooth mass, or a nonmass and the kinetic pattern of persistent enhancement showed a lower cancer rate than a nonsmooth mass and plateau or washout enhancement kinetics, the cancer rate was not significantly different according to the MRI features of the lesions.

**References**


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