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Comparison of the diagnostic performance of abbreviated MRI and full diagnostic MRI using a computer-aided diagnosis (CAD) system in patients with a personal history of breast cancer: the effect of CAD-generated kinetic features on reader performance

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AIM: To compare the diagnostic performance of abbreviated magnetic resonance imaging (MRI) and full diagnostic MRI with computer-aided diagnosis (CAD) system in patients with a personal history of breast cancer and to evaluate how the kinetic features affect the performance of two radiologists.

MATERIALS AND METHODS: Between 1 January 2014 and 31 December 2017, 3,834 breast MRI examinations in 2,310 patients with a history of breast cancer comprised the study population. MRI images were reviewed retrospectively by two radiologists. First, two radiologists independently reviewed T1-weighted images scanned at 90 seconds after the contrast medium injection and T2-weighted images. After 6 months, the two readers reviewed contrast-enhanced T1-weighted images with five consecutive delayed images using CAD. The diagnostic performance of the abbreviated-sequence and full-sequence MRI were compared.

RESULTS: Fifty-one intramammary recurrences were detected with breast MRI in 47 patients. Of the 51 tumour recurrences, 36 (70.6%) lesions occurred >3 years after initial cancer surgery and seven (13.7%) lesions at <2 years after initial surgery. The sensitivity and specificity were 92.2–94.1% and 97.6–98.6% on the abbreviated sequence and 94.1–96.1% and 97.9–98.3% on the full diagnostic MRI. Of 51 malignant lesions, six showed delayed persistent pattern, of which three lesions were non-mass enhancement and three lesions were small enhancing masses <1 cm.

CONCLUSION: Overall diagnostic performances of abbreviated MRI and full diagnostic MRI were similar in both readers. The CAD-generated kinetic features could affect reader performance and the sensitivity could be improved or the specificity improved according to the reader.

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Introduction

Breast MRI has high sensitivity for the diagnosis of breast cancer and many studies have reported the usefulness of breast MRI in the surveillance of high-risk women with a family history or genetic mutation.[1–3] Breast MRI is recommended for the surveillance of women with a lifetime breast cancer risk >20–25% according to the recommendations by the American Cancer Society, the American College of Radiology, and the Society of Breast Imaging[4–6]; however, in women with a personal history of breast cancer in which the lifetime breast cancer risk is >15–20%, the American College of Radiology stated that breast MRI may be considered.[5]

Personal history of breast cancer is an important risk factor for the development of subsequent breast cancer with a relative risk of 1.42 compared with a family history of breast cancer.[7] The reported 10-year breast cancer recurrence rate was 19.3% and 15-year mortality rate was 21.4%.[8] Even in early-stage patients with hormone receptor-positive breast cancer, the recurrence or subsequent breast cancer rates has been reported as 3%–5% per year.[8,9]

Development of ipsilateral breast recurrence or contralateral breast cancer was associated with increased risk of distant metastasis and breast cancer mortality.[10,11] Early detection of breast cancer recurrence in asymptomatic patients was associated with improved survival rate.[12,13]

Previous studies reported the usefulness of breast MRI for the surveillance of patients with a personal history of breast cancer.[7,14–19] The cancer detection rate ranged from 10.1 to 28.8 per 1,000 examinations and the positive predictive value (PPV) of biopsy recommendation ranged from 27% to 50%.

Computer-aided diagnosis (CAD) in breast MRI has been widely used and it could increase the sensitivity in patients with newly diagnosed breast cancer.[20–23] The purposes of the present study were to compare the diagnostic performance of abbreviated MRI and full diagnostic MRI with CAD system in patients with a personal history of breast cancer and to evaluate how the kinetic features affect the performance of two radiologists.

Materials and methods

Patients

This retrospective study was approved by the institutional review board with waver of the requirement for informed consent. Between 1 January 2014 and 31 December 2017, 3,995 breast MRI examinations were performed in 2,392 patients who had been previously treated for breast cancer, either with breast-conserving surgery (n=1535) or mastectomy (n=857). Of 3,995 breast MRI examinations, 161 were excluded either because the kinetic curve evaluation was not available (n=40) or their 12-month imaging follow-up information was unavailable (n=121). Ten breast MRI examinations that were performed for the evaluation of tumour recurrence detected at mammography or ultrasound (US) were not excluded, because MRI alone was reviewed without information of mammography or US. Of 41 intramammary recurrences diagnosed at MRI in the first instance, 17 lesions were detected on mammography, 22 lesions were not detected, and two patients did not undergo mammography. Finally, 3,834 breast MRI examinations in 2,310 patients with a personal history of breast cancer comprised the study population. Thirty-eight patients underwent four annual MRI screenings, 359 patients underwent three annual MRI screenings, 692 patients underwent two, 1,221 patients underwent one annual MRI screening.

MRI image acquisition

MRI images were obtained with a 3 T MRI system (Discovery MR750w, GE Healthcare, Milwaukee, WI, USA) or 1.5 T system (SignaHDxt; GE Healthcare, Milwaukee, WI, USA) depending on the clinical availability. The imaging sequences of the 3 T scanner consisted of fat-suppressed axial T2-weighted sequences (repetition time [TR]=4,000 ms, echo time [TE]=80 ms, flip angle=124°, matrix=320×256, field of view [FOV]=320×320 mm, section thickness=3 mm) and axial T1-weighted fat-suppressed 3D volumetric scans (TR=7 ms, TE=2 ms, flip angle=10°, matrix=300×300, FOV=320×320 mm, section thickness=2 mm, phase acquisition time=90 seconds). The imaging sequence of the 1.5 T scanner consisted of fat-suppressed axial T2-weighted sequences (TR=3,616 ms, TE=98 ms, flip angle=90°, matrix=320×256, FOV=300×300 mm, section thickness=3 mm) and axial T1-weighted fat-suppressed 3D volumetric scans (TR=5.1 ms, TE=2.4 ms, flip angle=10°, matrix=300×300, FOV=300×300 mm, section thickness=1.5 mm, phase acquisition time=90 seconds). Dynamic contrast-enhanced images were obtained before and at five time points after intravenous injection of 0.1 mmol/l gadolinium chelate per kilogram body weight (Gadovist, Bayer Schering Pharma, Berlin, Germany).

All contrast-enhanced T1-weighted images were transferred to a commercially available CAD system (CADstream, version 6.0; Confirma, Kirkland, WA, USA) and processed to generate enhancement kinetic parameters. The CAD system automatically segmented breast cancers and calculated the peak enhancement and the proportion of delayed enhancement pattern of breast tumours. The delayed enhancement pattern was classified as washout, plateau, and persistent pattern.

MRI image interpretation

MRI images were reviewed retrospectively by two radiologists with 8 and 15 years of experience in breast MRI. First, two radiologists independently reviewed fat-suppressed T2-weighted images and contrast-enhanced T1-weighted images scanned at 90 seconds after the contrast medium injection. They were compared with the previous MRI examinations, if the patients underwent preoperative or postoperative breast MRI. When

interpreting the MRI images, the radiologists were blind to the mammography and US findings.

After 6 months, the two readers independently reviewed fat-suppressed T2-weighted images and contrast-enhanced T1-weighted images with five consecutive delayed images after the contrast medium injection. A combination of contrast-enhanced images and CAD-generated images were used for the analysis. In addition, images could be compared with previous MRI images.

For the evaluation of diagnostic performance, the Breast Imaging-Reporting and Data System (BIRADS) final assessments were dichotomised, with categories 1, 2 and 3 indicating negative and 4 and 5 indicating positive test results.

Statistical analysis

The chi-square test and Fisher's exact test were used for the comparison of kinetic features between malignant and benign lesions. The diagnostic accuracy of the abbreviated sequence and full-dynamic sequence were compared with the CAD system using McNemar's test. All analyses were performed using the SPSS 23.0 statistical software package (IBM, Armonk, USA), with a value of $p<0.05$ considered to be significant.

Results

Characteristics of intramammary recurred lesions found on postoperative screening breast MRI

Fifty-one intramammary recurrences were detected at breast MRI in 47 patients. The characteristics of the 51 breast cancers detected at screening MRI are summarised in Table 1. The mean age was 50 years (standard deviation, 8 years). The median interval between the initial cancer surgery and tumour recurrence on MRI was 44 months (range, 12–224 months) and the mean interval was 66 months (SD, 54). Of 51 tumour recurrences, 36 (70.6%) lesions occurred at >3 years after the initial cancer surgery and seven (13.7%) lesions at <2 years after initial surgery. Among seven lesions that occurred at <2 years after initial surgery, all seven (100%) lesions were ipsilateral recurrence and three (42.8%) were in patients who underwent neoadjuvant chemotherapy. The median size was 1.3 cm (range, 0.5–6.1 cm). Of 51 lesions, 46 (90.2%) lesions were mass on MRI and five (9.8%) lesions were non-mass enhancement.

MRI CAD kinetic features of recurred malignant lesions and false-positive lesions on MRI

Of the 51 malignant lesions, 48 (94.1%) lesions showed initial fast enhancement and 3 (5.9%) lesions showed initial medium enhancement (Table 2). Regarding the delayed kinetic features, washout pattern was noted in 33 (64.7%) lesions, plateau pattern in 12 (23.5%) and persistent pattern in six (11.8%). Of the six malignant lesions showing delayed persistent pattern, three lesions were non-mass enhancement and three lesions were small enhancing masses <1 cm.

Table 1
Characteristics of 51 malignant lesions found on postoperative screening breast magnetic resonance imaging (MRI) in 47 breast cancer patients.

Characteristics	Tumour recurrences detected on MRI
Age	
Mean±SD	50±8
Interval between the initial cancer surgery and tumour recurrence on MRI (months)	
Median (min–max)	44 (12–224)
Mean±SD	66±54
Interval between the initial cancer surgery and tumour recurrence on MRI	
Between 12–24 months	7 (13.7%)
Between 24–36 months	8 (15.7%)
Between 3–5 years	19 (37.3%)
More than 5 years	17 (33.3%)
Site of tumour recurrence	
Ipsilateral breast recurrence	34 (66.7%)
Ipsilateral chest wall recurrence after mastectomy	2 (3.9%)
Contralateral breast recurrence	11 (21.6%)
Bilateral breast recurrence	4 (7.8%)
Pathology at recurrence	
Ductal carcinoma in situ	13 (25.5%)
Invasive ductal carcinoma, not otherwise specified	31 (60.8%)
Invasive lobular carcinoma	3 (5.9%)
Others[a]	4 (7.8%)
Lesion size (cm)	
Median (min–max)	1.3 (0.5–6.1)
Mean±SD	1.6±1.1
Morphology on MRI	
Mass	46 (90.2%)
Non-mass enhancement	5 (9.8%)

[a] Other cancers include one mucinous carcinoma, one invasive micropapillary carcinoma, one adenoid cystic carcinoma, and one Paget's disease.

Table 2
Comparison of the magnetic resonance imaging (MRI) computer-aided diagnosis (CAD) kinetic features of 51 malignant lesions and 98 false-positive benign lesions categorised as suspicious lesions (category 4 or 5) on MRI by two readers.

Kinetic features	Malignant (n=51)	Benign (n=98)	p-Value
Initial enhancement			0.248
Fast	48 (94.1%)	90 (91.8%)	
Medium	3 (5.9%)	3 (3.1%)	
Slow	0 (0%)	5 (5.1%)	
Delayed enhancement			<0.001
Washout	33 (64.7%)	30 (30.6%)	
Plateau	12 (23.5%)	31 (31.6%)	
Persistent	6 (11.8%)	37 (37.8%)	

Of 98 false-positive benign lesions that were categorised as suspicious lesions (category 4 or 5) on MRI by either readers, delayed washout pattern was noted in 30 (30.6%) lesions, persistent pattern in 37 (37.8%), and plateau pattern in 31 (31.6%) lesions.

Comparison of BIRADS assessment and diagnostic performance of abbreviated MRI and full diagnostic MRI with CAD system in two readers

Table 3 showed the detailed information about BIRADS assessment of each reader. Among the abbreviated

Table 3
BIRADS assessment according to the readers in abbreviated magnetic resonance imaging (MRI) and full diagnostic MRI with computer-aided diagnosis (CAD).

	Reader 1		Reader 2	
	Abbreviated MRI	Full diagnostic MRI with CAD	Abbreviated MRI	Full diagnostic MRI with CAD
BIRADS 1 or 2	89% (3,411/3,834)	88.9% (3,409/3,834)	88% (3,375/3,834)	88.4% (3,388/3,834)
BIRADS 3	7.4% (284/3,834)	7.8% (298/3,834)	9.4% (360/3,834)	8.7% (334/3,834)
BIRADS 4A or 4B	2.8% (106/3,834)	2.2% (86/3,834)	2.1% (82/3,834)	2.2% (83/3,834)
BIRADS 4C or 5	0.9% (33/3,834)	1.1% (41/3,834)	0.4% (17/3,834)	0.8% (29/3,834)

Breast Imaging-Reporting and Data System (BIRADS).

sequences, two readers scored BIRADS category 1, 2, or 3 indicating negative results 96.4% (3695/3834) and 97.4% (3735/3834), and BIRADS category 4 or 5 indicating positive results in 3.6% (139/3834) and 2.6% (99/3834).

Among the full sequence with CAD, two readers scored BIRADS category 1,2 or 3 indicating negative results in 96.7% (3707/3834) and 97.1% (3722/3834) and BIRADS category 4 or 5 indicating positive results in 3.3% (127/3834) and 2.9% (112/3834).

Among 51 intramammary recurrences, the two readers detected 48 (94.1%) and 47 (92.2%) cancers with NPVs of 99.9% and 99.9% on abbreviated MRI (Table 4). The readers showed specificities of 97.6% and 98.6%; PPV of 34.5% and 47.5%; and cancer detection rates of 12.5 and 12.3 per 1,000 examinations, respectively.

For full diagnostic MRI with CAD system, the readers showed sensitivities of 94.1% and 96.1%; specificities of 97.9% and 98.3%; PPV of 37.8% and 43.8%; NPVs of 99.9% and 99.9%; and cancer detection rates of 12.5 and 12.8 per 1,000 examinations, respectively. There were no significant differences in diagnostic performance between abbreviated sequence and full-dynamic sequence with CAD system for both readers ($p>0.05$).

On abbreviated sequence, there were three false-negative cases for reader 1 and four false-negative cases for reader 2. With the addition of CAD, the number of false-negative cases did not change for reader 1 and decreased from four to two for reader 2.

On abbreviated sequence, there were 91 and 52 false-positive cases, respectively. With the addition of the CAD system, the number of false-positive cases decreased from 91 to 79 for reader 1 and increased from 52 to 63 for reader 2.

Characteristics and reasons of false-negative cases in abbreviated MRI and full diagnostic MRI

The characteristics and reasons for five false-negative cases are summarised in Table 5. The reasons for false-negative cases were small size of linear non-mass enhancement ($n=1$), small size of mass or focus with circumscribed margin ($n=2$), moderate background parenchymal enhancement causing the masking of non-mass enhancement ($n=1$), and small size mass with persistent kinetics ($n=1$). Representative cases are presented in Figs 1–3.

Discussion

Usefulness of breast MRI for the surveillance of patients with a personal history of breast cancer has been reported in many studies.[7,14–19] In women diagnosed at 50 years or younger who underwent breast-conserving surgery, MRI screening detected 3.8 additional breast cancers per 1,000 women showing increased sensitivity over mammography alone.[24]

The present results showed that the diagnostic accuracy of the abbreviated sequence were equivalent to those of full diagnostic sequence with CAD system. Several studies also reported that the abbreviated MRI protocol was efficient for the screening for tumour recurrence in patients with a personal history of breast cancer and for the detection of

Table 4
Comparison of diagnostic performance of abbreviated magnetic resonance imaging (MRI) and full diagnostic MRI with computer-aided diagnosis (CAD) in two readers.

	Reader 1		Reader 2	
	Abbreviated MRI	Full diagnostic MRI with CAD	Abbreviated MRI	Full diagnostic MRI with CAD
Sensitivity (%)	94.1 (48/51)	94.1 (48/51)	92.2 (47/51)	96.1 (49/51)
95% Confidence interval	82.77–98.47	82.77–98.47	80.25–97.46	85.41–99.32
Specificity (%)	97.6 (3,692/3,783)	97.9 (3,704/3,783)	98.6 (3,731/3,783)	98.3% (3,720/3,783)
95% Confidence interval	97.04–98.05	97.39–98.33	98.19–98.96	97.86–98.71
PPV (%)	34.5 (48/139)	37.8 (48/127)	47.5 (47/99)	43.8 (49/112)
95% Confidence interval	26.81–43.13	29.47–46.87	37.44–57.71	34.5–53.43
NPV (%)	99.92 (3,692/3,695)	99.92 (3,704/3,707)	99.89 (3,731/3,735)	99.94 (3,720/3,722)
95% Confidence interval	99.74–99.98	99.74–99.98	99.71–99.97	99.78–99.99
Cancer detection rate for intramammary lesions[a]	12.5	12.5	12.3	12.8

PPV, positive predictive value; NPV, negative predictive value.
[a] CDR cancer detection rate for intramammary lesions is total number of intramammary cancers detected at MRI per 1,000 examinations.

Table 5
The characteristics and reasons of false negative cases in abbreviated magnetic resonance imaging (MRI) and full diagnostic MRI.

	Reader and MRI protocol	Reason for false negative	Lesion type	Delayed kinetics	Size (cm)	Pathology
Case 1	Both readers on both abbreviated and full diagnostic MRI	Small size Linear NME	NME	Persistent	1.1	Ductal carcinoma in situ
Case 2	Both readers on abbreviated MRI Reader 2 on full diagnostic MRI	Circumscribed margin	Mass	Washout	0.5	Invasive ductal carcinoma
Case 3	Both readers on abbreviated MRI Reader 1 on full-diagnostic MRI	Moderate BPE and masking of non-mass enhancement	NME	Washout	2.0	Ductal carcinoma in situ
Case 4	Reader 2 on abbreviated MRI	Circumscribed margin	Mass	Washout	0.8	Invasive micropapillary carcinoma
Case 5	Reader 1 on full diagnostic MRI	Kinetics	Mass	Persistent	0.6	Mucinous carcinoma

NME, non-mass enhancement.

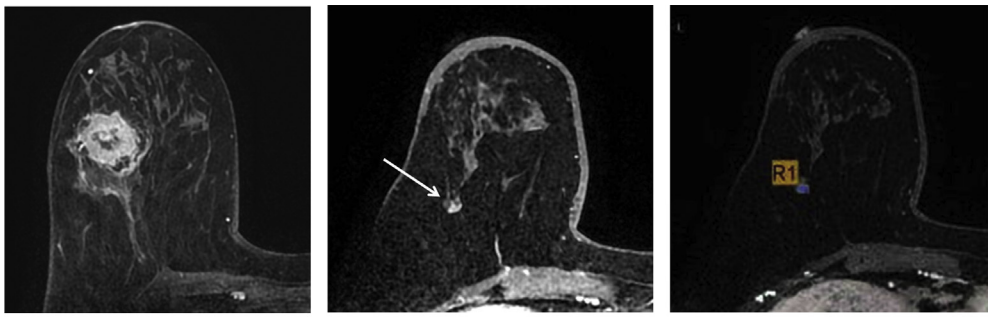

Figure 1 Screening breast MRI images of 54-year-old woman with a personal history of ipsilateral breast cancer. (a) The patient underwent right breast-conserving surgery for newly diagnosed breast cancer in right breast 10 o'clock direction. (b) After 2 years, early contrast-enhanced axial image shows a 0.7 cm irregular enhancing lesion in right breast 8 o'clock direction (arrow). Reader 1 interpreted this lesion as category 4b and reader 2 as category 4a. (c) On the same image with CAD, the lesion shows delayed persistent enhancement pattern. Both readers changed the diagnosis to category 3. This lesion has shown no interval change for 3 years and is considered a benign lesion.

breast cancer in patients with dense breast.[25,26] In the study of Kuhl *et al.*, patients with mild to moderate risk were enrolled for the screening breast MRI and the sensitivity was 100% in both abbreviated protocol and full diagnostic protocol.[25] The specificity (94.3% versus 93.9%) and positive predictive value (24.4% versus 23.4%) were also equivalent between two protocols.

In the present study, the sensitivity ranged from 92.2% to 96.1%. Improved sensitivity was noted for reader 2 and did not change for reader 1 with the addiction of CAD. Among four false-negative lesions on the full diagnostic sequence, one lesion was a very small mass <1 cm showing the delayed persistent pattern and one lesion was linear non-mass enhancement showing persistent kinetics. In the present results, of 51 recurred malignant lesions, six lesions showed the delayed persistent pattern. Of the six lesions, three were small lesions <1 cm and three were non-mass enhancement. Thus, the delayed persistent kinetic curve pattern could decrease the sensitivity, especially in small cancers or cancers presented as non-mass enhancement.

CAD of breast imaging has been applied in the clinical setting for the analysis of enhancement kinetics and there are many studies reporting the clinical implication of enhancement kinetics in breast cancer patients. The kinetic features using CAD were associated with survival outcome, tumour aggressiveness, molecular subtype, pathological response to neoadjuvant chemotherapy, and tumour-infiltrating lymphocytes.[27–30]

Many studies also reported the usefulness of the CAD system for the diagnosis of breast cancer. In the study of

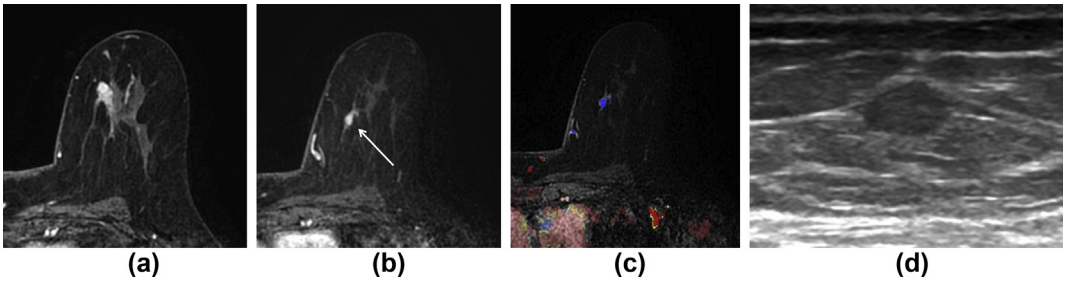

Figure 2 Screening breast MRI images of 77-year-old woman with a personal history of ipsilateral breast cancer. (a) The patient underwent left breast-conserving surgery for newly diagnosed invasive ductal carcinoma, not otherwise specified. (b) After 4 years, a newly developed enhancing lesion is noted in the left breast 10 o'clock direction on early contrast-enhanced axial image (arrow). Both readers interpreted this lesion as category 4a. (c) On the same image with CAD, the lesion shows delayed persistent enhancement pattern. Both readers changed the diagnosis to category 3. (d) US-guided core-needle biopsy was performed and the histopathological result was mucinous carcinoma. This case is an example of false negative with the addition of CAD system.

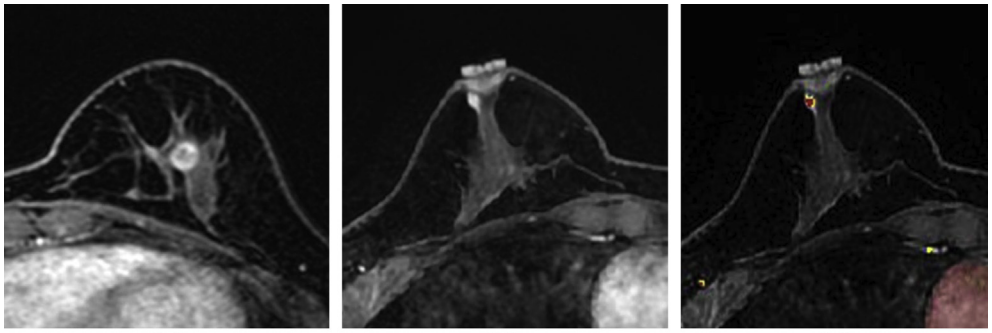

Figure 3 Screening breast MR images of 40-year-old woman with personal history of contralateral breast cancer. (a) The patient underwent left breast conserving surgery for newly diagnosed breast cancer in left breast 4 o'clock direction. (b) After 1 year, early contrast-enhanced axial image shows 0.5 cm oval enhancing lesion in right breast subareolar (arrow). Reader 1 interpreted this lesion as category 4a and reader 2 as category 3. (c) On the same image with CAD, lesion shows delayed washout enhancement pattern. Reader 1 changed the diagnosis as category 4b and reader 2 as category 4a. US-guided core needle biopsy was performed and the pathologic result was fibrocystic change. This case is an example of false positive with the addition of CAD system.

Shimauchi *et al.*, when CAD was used, the sensitivity and diagnostic accuracy were improved significantly.[31] In the study of Gweon *et al.*, use of MRI CAD improved the PPV by reducing the false-positive rate, especially for the evaluation of masses or foci.[17] They concluded that if the suspicious mass did not show early enhancement at a 50% threshold nor delayed washout pattern, follow-up could be considered. In another study, for the evaluation of contralateral lesions in patients with newly diagnosed breast cancer, use of MRI CAD tended to increase the sensitivity and decrease the specificity compared to the visual assessment of kinetic features.[20] Seo *et al.* analysed the kinetic features of missed cancers on screening MRI.[21] Of the 36 visible findings on prior MRI images, 33.3% (12 of 36) of the lesions were determined to be actionable and all actionable findings showed delayed washout or plateau kinetic patterns.

Thus, the effect of the CAD system is still controversial causing increased sensitivity and decreased specificity in some studies and increased specificity in other studies. In addition, in the present results, the specificity increased for reader 1 and decreased for reader 2. Reader 1 tended to interpret a new enhancing lesion more sensitively compared to reader 2, and if the new enhancing lesion showed delayed persistent kinetic feature on CAD system, the diagnosis was downgraded from category 4 to category 3 resulting in increased specificity. In contrast, the reason why the specificity had decreased for reader 2 after CAD application could be that several benign lesions that were classified as category 3 were upgraded to category 4 due to the delayed washout or plateau kinetic features on CAD. In the present study, of 98 benign lesions suspected to be malignant lesions by two readers, 30 (30.6%) lesions had washout and 31 (31.6%) had plateau kinetic features.

The overall cancer detection rate ranged from 12.3 to 12.8 according to the reader and use of the CAD system. The cancer detection rates are similar to the results of previous studies which reported rates from 10.1 to 28.8.[7,14–19] One previous study reported that a >24-month interval from the initial operation and MRI was an independent factor associated with MRI-detected cancer in patients with a history of breast-conserving surgery.[32] In another study, the cancer detection rate was 17.4 per 1,000 examinations for MRI performed >3 years after surgery, and it was significantly lower, 1.4, for MRI <3 years after surgery.[33] The present results showed that 43 (86%) of 50 malignant lesions were detected at MRI >24 months after the initial surgery and 35 (60%) lesions were >3 years after the initial surgery. Only seven (14%) lesions were detected on MRI <24 months after the operation. The present results supported the previous results that screening breast MRI could be more effective >24 months after the initial operation in patients with a personal history of breast cancer.

There are several important limitations in the present study. First, this was a retrospective study that included patients who were referred by physicians and underwent screening breast MRI. Selection bias could have been introduced through the inclusion of these patients. Second, of 98 benign lesions that were suspected as category 4 or 5 by two readers, all lesions are not confirmed by histopathology; however, patients with at least 12 months of follow-up were included and there was no evidence of malignancy on follow-up imaging. Third, many patients underwent more than two rounds of postoperative MRI examinations and when the readers interpreted the MRI, they could compare it with preoperative or previous screening MRI. This could inflate the results because there could be memory effects. Fourth, both 3 and 1.5 T MRI systems were used and the field strength could affect the contrast enhancement kinetics. Finally, only two readers interpreted MRI images in the present study. More readers would be better for the exact comparison of diagnostic accuracy.

In conclusion, the diagnostic performance of abbreviated MRI was equivalent to those of full diagnostic MRI. The semi-quantitative kinetic features from CAD system could affect the reader performance for the evaluation of MRI in patients with a personal history of breast cancer. According

to the readers, the sensitivity could be improved or the specificity improved.

Conflict of interest

The authors declare no conflict of interest.

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