Received:
2 July 2015

Revised:
27 October 2015

Accepted:
12 November 2015

doi: 10.1259/bjr.20150543

Cite this article as:

Proulx F, Correa J, Ferré R, Omeroglu A, Aldis A, Meterissian S, et al. Value of pre-operative breast MRI for the size assessment of ductal carcinoma *in situ*. *Br J Radiol* 2016; **89**: 20150543.

FULL PAPER

Value of pre-operative breast MRI for the size assessment of ductal carcinoma *in situ*

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Objective: To retrospectively evaluate the accuracy of pre-operative breast MRI and mammography in determining the size of ductal carcinoma *in situ* (DCIS) compared with the histopathological results.

Methods: 79 patients [mean age: 56.5 (standard deviation 10.2) years] with pathologically proven DCIS (79 lesions) obtained a bilateral mammogram and a pre-operative contrast-enhanced MRI. The accuracy of MRI and mammography to detect tumour size were estimated and compared, using histopathological size as the gold standard, on the subjects with measurements with both modalities ($n = 60$).

Results: MRI detected 67 (85%) lesions, mammography detected 72 (91%) and both modalities detected 60 (76%). Median DCIS size detected by mammography vs

MRI was smaller (1.55 vs 1.65 cm). Out of these 60 cases, compared with the histopathological size, the accuracy of MRI and mammography was 0.66 and 0.56, respectively ($p = 0.045$). MRI showed better accuracy than mammography for younger patients (age ≤ 50 years, $p = 0.003$). For tumour nuclear grade, there was a statistically significant difference for the intermediate level, with higher accuracy for MRI ($p = 0.03$).

Conclusion: MRI was more accurate than mammography in DCIS size assessment when visible, particularly in lesions of intermediate grade and in patients less than 50 years of age.

Advances in knowledge: Breast MRI may help in management of DCIS of intermediate grade and in females less than 50 years of age.

INTRODUCTION

Ductal carcinoma *in situ* (DCIS) is a form of non-invasive carcinoma in which malignant cells are still confined to the duct which still has an intact basement membrane.¹ The literature^{1,2} has reported that DCIS accounts for 15–25% of all breast cancers which can progress to invasive carcinoma in 30–50% of cases. Avoiding this progression and minimizing locoregional recurrences are the primary goals of treatment, which is most commonly performed using breast conservation therapy.^{3–6}

In the pre-operative treatment planning, obtaining precise information on the extent and distribution of DCIS is important in determining the extent of surgery required. Mammography is the primary tool of the radiologists in the detection and size assessment of microcalcifications, but it still has some limitations. Indeed, mammography can underestimate or overestimate the histopathological tumour size, especially in dense breasts or in cases where DCIS is not entirely calcified.^{7–9} Inaccurate mammographic assessment of the tumour size can lead to positive surgical margins and is a risk factor for locoregional recurrence.^{6,10}

Multiple studies^{11–16} have demonstrated that MRI can be a useful tool for the evaluation of tumour size in patients with invasive breast cancer. As for patients with DCIS, MRI seems overall more accurate in predicting the size of DCIS than mammography,^{10,17} but its value as a diagnostic tool in the pre-operative setting remains controversial.^{18–21} Hence, there are no standardized recommendations for the use of MRI in the pre-operative setting in patients with DCIS.

The purpose of this study was to determine the value of pre-operative breast MRI in the assessment of DCIS size in comparison with the histopathological size and to compare the accuracy of MRI with that of mammography.

METHODS AND MATERIALS

This retrospective study was approved by the McGill University Health Center research ethics board, which waived the need for informed consent.

Patient population and inclusion criteria

A total of 1457 patients had breast MRI between December 2007 and January 2011 at our institution. Among these

patients, 286 patients had pre-operative studies for diagnosed breast cancer (20%, 286/1457). Of these 286 patients, 79 patients were diagnosed with DCIS (28%, 79/286). Thus, the study population consisted of 79 cases of pathologically proven DCIS diagnosed [age in years: mean 56.5 (standard deviation 10.2), range 37–77]. Every patient obtained pre-operative contrast-enhanced MRI.

Imaging studies

Mammography was performed using dedicated film-screen mammographic equipment (LORAD M-IV mammographic unit; LORAD, Danbury, CT). Standard craniocaudal and mediolateral oblique projections were obtained for all patients. Additional mammographic projections were performed as needed.

MRI was performed on 1.5-T system magnet (Signa® TwinSpeed Excite 1.5 T; GE Medical Systems, Milwaukee, WI), using eight-channel breast phase array breast coil for signal reception. We utilized the following protocols: axial no fat-saturated three-dimensional T_1 weighted volume imaging breast assessment (VIBRANT) [repetition time (TR)/echo time (TE), 7.6/3.6 ms; flip angle, 10°; section thickness, 2.2 mm; matrix size, 420 × 420; gap, 0 mm], axial two-dimensional fast relaxation fast spin echo (TR/TE, 5525/102 ms; echo train length, 17; section thickness, 3 mm; matrix size, 384 × 224; gap, 0 mm), fat-saturated gadolinium-enhanced images (three phases) after administration of 0.1 mmol kg⁻¹ of Gadobutrol (Gadovist®; Shering; Bayer Healthcare Pharmaceuticals, Wayne, NJ) power-injected at 2 ml s⁻¹ followed by a 10-ml saline flush with subtraction in the axial plane (three-dimensional VIBRANT, TR/TE, 7/2.8 ms; flip angle, 10°; slice thickness, 2.2 mm; matrix size, 412 × 320; no gap) and 10-min delayed sagittal two-dimensional VIBRANT (TR/TE, 7.9/4.2 ms; flip angle, 10°; section thickness, 3 mm; matrix size, 384 × 288; gap, 3 mm). Breast MRI computer-aided detection software (Aegis 3.0; Sentinelle Medical Inc., Toronto, ON, Canada) was utilized to generate subtracted images, maximum intensity projection and kinetic colour maps and graphs.

Breast biopsy method

Biopsies were performed either under stereotactic [11-gauge directional vacuum-assisted breast biopsy procedures (Mammotome®; Ethicon Endo-Surgery, Cincinnati, OH) and 9-gauge directional vacuum-assisted breast biopsy procedures (ATEC®; Suros Surgical Systems, Indianapolis, IN), on a digital stereotactic table (LoRad DSM; Hologic, Bedford, MA)] ($n = 48$; 61%) or sonographic guidance [14-gauge spring-loaded core biopsy needle (Bard® Magnum®; Bard Urological, Covington, GA)] ($n = 27$; 34%) or MRI guidance [9-gauge directional vacuum-assisted breast biopsy procedures (ATEC; Suros Surgical Systems)] ($n = 4$; 5%). All stereotactically and sonographically guided biopsies were performed prior breast MRI (usually 1–3 weeks). Specimen radiographs were routinely obtained for lesions presenting as microcalcifications. All diagnostic breast biopsies were needle biopsies, and no diagnostic breast biopsies were performed by surgical excision.

Imaging review

Mammographic and MRI characteristics were reviewed by consensus by two radiologists (BM and AA) with 16 and

10 years' experience in breast imaging according to the fourth edition of the mammography and MRI breast imaging reporting and data system categories.²²

Mammographic findings

Breast parenchymal density was classified according to the American College of Radiology Breast Imaging Reporting and Data System. The morphology of the mammographic lesions were compiled and categorized as mass, microcalcifications, mass with microcalcifications, focal asymmetry or architectural distortion. For lesions presenting as masses, the shape, margins and density were also evaluated. For microcalcifications, the morphology and distribution characteristics were also recorded. The greatest dimension of the lesion was measured on the more appropriate view (craniocaudal, mediolateral oblique or true lateral views). In cases of vacuum-assisted biopsy of microcalcifications, the percentage of microcalcifications removed was determined on immediate post-biopsy stereotactic images and specimen X-rays.

MRI findings

For each MRI, the background enhancement (nil, mild, moderate and intense), the morphology (focus, mass, non-mass enhancement) and size of the lesions were evaluated when present. Lesion size was obtained from post-contrast images, native axial images, subtracted axial images or delayed sagittal images. The shape, margins and internal enhancement characteristics of each lesion presenting as a mass were reviewed. Similarly, the distribution, enhancement pattern and symmetry of the lesions consisting of non-mass enhancement were also recorded. The presence of a post-biopsy haematoma was also recorded.

Surgical intervention

The primary surgical treatment included mastectomy ($n = 14$; 18%) and breast conservative surgery ($n = 59$; 75%). If the surgical margins were involved or close (<1 mm), further excision or mastectomy was performed ($n = 6$; 8%).

Pathology

DCIS was classified according to the nuclear grade (high, intermediate and low), the presence of necrosis and microinvasion (microinvasion or pure DCIS). Microinvasion was defined as extension of the cancer cells beyond the basement membrane into the adjacent tissues with no focus >0.1 cm in the greatest dimension.²³ Segmental mastectomies were entirely submitted for microscopic evaluation, and sections taken for paraffin blocks were mapped.

Size estimation

The reference standard was set as the maximum lesion size determined at histopathology. The longest axis of the lesion was used to assess tumour size on imaging. When no lesion was identified on mammography or MRI, it was recorded as non-visible.

Using the true histopathological estimate of DCIS size as the gold standard, size estimation was assessed in two ways. First, we compared the diagnostic accuracy of MRI and mammography

(when visible). Second, reflecting the clinical practice, we classified the tumour size assessment of each imaging modality (mammogram and MRI) as being underestimated, accurately estimated and overestimated. Underestimation of the true DCIS size occurred in cases in which the imaging modality underestimated the histopathological size by >1 cm. An overestimation occurred in cases when the imaging modality overestimated the histopathological size by >1 cm. Otherwise, when the difference between the imaging and histopathological size of the lesion was ≤ 1 cm, the size assessment was estimated to be accurate.

Statistical analyses

Descriptive statistics summarize all study variables. For categorical variables, we reported counts and percentages, whereas for continuous variables, we reported means and standard deviations when the distribution of values showed evidence of being approximately normal; otherwise, we reported medians and interquartile range (IQR). All hypothesis tests were two-sided and performed at a significance level of 0.05. We used the software SAS v. 9.3 (SAS Institute, Inc., Cary, NC), for all statistical analyses.

Accuracy

We estimated and compared diagnostic accuracy values for detecting DCIS size at mammography and MRI, based on paired observations from the set of patients with measurements from both mammography and MRI, using histopathologic measurements as the gold standard.

For the estimation of diagnostic accuracy values, we used the method proposed by Obuchowski²⁴ because the gold standard of this study is continuous scale. Obuchowski's method allows for a receiver operating characteristic-type measure of diagnostic accuracy without the need for dichotomizing the gold standard. Furthermore, the method provides for a non-parametric estimate of diagnostic accuracy and its standard error, for the computation of confidence intervals (CI), and it is based on a modified version of Kendall's τ .²⁵

For the statistical comparison of the diagnostic accuracies, we used a hypothesis test also proposed by Obuchowski.²⁴ Furthermore, the same approach of estimation and comparison of accuracies of mammography and MRI was repeated while stratifying the paired samples into subgroups defined by age (≥ 50 years or <50 years), mammographic and MRI density [low (fatty and scattered) vs high (heterogeneous and extremely dense)], tumour grade, presence of microinvasion and necrosis.

We also reported the results of tumour size assessments, categorized as underestimation, accurate estimation and overestimation, as defined in the Methods section, cross-classified for mammography and MRI. Proportions were compared using Stuart–Maxwell²⁶ test for marginal homogeneity.

Subgroup comparison

In order to identify factors that may influence the performance of MRI, we compared true positive and false negative subgroups for different variables of interest (age, histopathological size,

Table 1. Characteristics of lesions seen at mammography ($n = 72$) and lesions seen at breast MRI ($n = 67$)

Variable	Lesions seen at mammography ($n = 72$)	Lesions seen at breast MRI ($n = 67$)
Age (years), mean (SD)	56.11 (10.03)	56.06 (10.26)
Final pathologic size (cm), median (IQR)	1.65 (0.60–4.0)	2.0 (0.7–4.0)
Percentage of microcalcifications removed, median (IQR)	N/A	10 (0–70)
Nuclear grade, n (%)		
Low	18 (25.0)	15 (22.4)
Intermediate	40 (55.6)	38 (56.7)
High	14 (19.4)	14 (20.9)
Necrosis, n (%)		
Yes	45 (62.5)	44 (65.7)
No	27 (37.5)	23 (34.3)
Post-biopsy haematoma, n (%)	N/A	8 (11.9)
Background enhancement, n (%)		
Nil	N/A	11 (16.4)
Mild		45 (67.2)
Moderate		8 (11.9)
Intense		3 (4.5)

IQR, interquartile range from 25% percentile to 75% percentile; N/A, not available; SD, standard deviation.

microcalcifications removed, breast density, background parenchymal enhancement, tumour grade, presence of necrosis and presence of haematoma). We performed a similar analysis for mammography. Comparisons for continuous variables were performed with *t*-tests for independent groups when the distribution of values showed evidence of being approximately normal; otherwise, we used the Wilcoxon rank-sum test. For categorical variables, we used χ^2 test when expected values were >5 ; otherwise, we used Fisher's exact test.

RESULTS

Imaging findings

Of the 79 DCIS lesions, 7 (9%) were detected by MRI only, 12 (15%) by mammography only and 60 (76%) by both mammography and MRI. Thus, the total number of lesions detected by MRI was 67 (85%) and by mammography 72 (91%).

Mammographic findings

Among the 79 patients, 13 patients (16%) had extremely dense breasts, 30 patients (38%) had heterogeneously dense breasts, 32 patients (41%) had scattered fibroglandular densities and 4 patients (5%) had fatty breast parenchyma.

Of the 72 patients, for whom mammography detected the lesion, the mammographic index lesion was identified as a mass alone in 4 patients (6%), microcalcifications alone in 57 patients

(79%), mass with associated microcalcifications in 4 patients (6%), architectural distortion in 2 patients (3%) and focal asymmetry in 5 patients (7%).

The median DCIS size detected by mammography (72 lesions) was 1.55 cm (IQR 1.0–2.7 cm). The median pathological size of the lesions detected by mammography was 1.65 cm (IQR 0.6–4.0 cm) (Table 1).

MRI findings

When the lesion was detected by MRI (67 lesions), it demonstrated an area of non-mass enhancement in 51 cases (76%). Of the 12 false-negative MRI examinations, 7 cases (58%) demonstrated all the targeted microcalcifications to have been removed during the stereotactic vacuum-assisted biopsy.

The median DCIS size detected by breast MRI (67 lesions) was 2.6 cm (IQR 0.9–4.5 cm). The mean pathological size of the lesions detected by MRI was 2.0 cm (IQR 0.7–4.0 cm) (Table 1).

Biopsy technique

The presence of haematoma was recorded on pre-operative breast MRI in 10 (21%) of the 48 patients (median size 1.3 cm, IQR 1.1–1.6 cm) who underwent a stereotactically guided biopsy. Of the 12 false-negative MRI examinations, post-biopsy haematoma was present in 2 (17%) of those cases.

Table 2. Comparison between lesions visible at breast MRI ($n = 67$) and lesions not visible at breast MRI ($n = 12$)

Variable	Negative breast MRI ($n = 12$)	Positive breast MRI ($n = 67$)	<i>p</i> -value
Age (years), mean (SD)	59.25 (9.61)	56.06 (10.26)	0.3 ^a
Final path size (cm), median (IQR)	0.9 (0.3–4.0)	2.0 (0.7–4.0)	0.2 ^b
Percentage removed, median (IQR)	100 (75–100)	10 (0–70)	<0.0001 ^b
Nuclear grade, <i>n</i> (%)			0.4 ^c
Low	5 (41.7)	15 (22.4)	
Intermediate	5 (41.7)	38 (56.7)	
High	2 (16.7)	14 (20.9)	
Necrosis, <i>n</i> (%)			
Yes	5 (41.7)	44 (65.7)	
No	7 (58.3)	23 (34.3)	
Post-biopsy haematoma, <i>n</i> (%)			
Yes	2 (16.7)	8 (11.9)	
No	10 (83.3)	59 (88.1)	
Background enhancement, <i>n</i> (%)			
Nil	0	11 (16.4)	
Mild	9 (75.0)	45 (67.2)	
Moderate	2 (16.7)	8 (11.9)	
Intense	1 (8.3)	3 (4.5)	

IQR, interquartile range from 25% percentile to 75% percentile; SD, standard deviation.

^a*t*-test.

^bWilcoxon rank-sum test.

^cFisher's exact test.

The median percentage removal of microcalcifications during stereotactically guided biopsies was 40 (IQR 0–90). For the 12 false-negative MRI examinations, the median percentage removal was 100 (IQR 75–100), as compared with 10 (IQR 0–70) for the 67 true-positive MRI examinations (Table 2). This difference was statistically significant (Wilcoxon rank-sum test, $p < 0.0001$).

Pathological findings

High-grade DCIS was found in 16 patients (20%), whereas low- and intermediate-grade DCIS occurred in 63 patients (80%). Necrosis was present in 49 patients (62%) and was absent in 30 patients (38%). Pure DCIS without microinvasion was seen in 73 patients (92%). 47 (59%) lesions were found in the left breast and 32 lesions (41%) were located in the right breast.

The median DCIS size at final pathology (79 lesions) was 1.7 cm (IQR 0.7–4 cm). The false-negative lesions detected by mammography ($n = 7$) showed a median histopathological size of 2.0 cm (IQR 0.7–3.2 cm) (Table 3) and 0.9 cm (IQR 3.0–4.0 cm) (Table 2) for the false-negative lesions detected by MRI ($n = 12$).

Accuracy in size evaluation

The estimation and comparison of diagnostic accuracies, using histopathological size as the gold standard, showed that out of the 60 cases detected with both modalities, the accuracy of MRI was 0.66 (95% CI, 0.56–0.75). This can be interpreted as, given two randomly selected patients, there is a 66% chance that a patient with high tumour size (as measured by the gold standard) will have higher MRI size measurement than that of one having low tumour size. The accuracy estimate for mammography was 0.56 (95% CI, 0.47–0.66). The difference

in accuracies of 0.10 was statistically significant (95% CI, 0–0.19, $p = 0.045$). Table 4 shows subgroup comparisons of accuracies for variables of interest. The accuracy of MRI seems to be higher than that of mammography for the subjects with age less than or equal to 50 years ($p = 0.003$) but not for the subjects with age above 50 years ($p = 0.75$). For tumour nuclear grade, there was a statistically significant difference only for the intermediate level, with a higher accuracy for MRI ($p = 0.03$).

Table 5 shows the cross-classification of estimation accuracy according to the classification explained in the Methods section. We note that on mammograms, the size of the lesion was underestimated in 18 cases (30.0%), accurate in 25 cases (41.7%) and overestimated in 17 cases (28.3%). As for MRI, underestimation of the size was seen in 11 cases (18.3%), accurate estimation in 30 cases (50.0%) and overestimation in 19 cases (31.7%). The Stuart–Maxwell test shows no difference in the marginal proportions ($\chi^2 = 2.31$, $df = 1$, $p = 0.13$).

Discordant cases in which MRI overestimated and mammography underestimated the lesions, or *vice versa*, were rare. Both MRI and mammography were accurate in 16 cases (26.7%) (Table 5).

DISCUSSION

When the lesions were detected by mammography and MRI, the majority of them presented as microcalcifications (79%) or non-mass enhancement (76%), which is in agreement with the published literature.^{27,28}

In our study, mammography detected more lesions than MRI did (72 true positive at mammography vs 67 true positive at

Table 3. Comparison between lesions visible at mammography and lesions not visible at mammography

Variable	Negative mammogram ($n = 7$)	Positive mammogram ($n = 72$)	p -value
Age (years), mean (SD)	61 (11.36)	56.11 (10.03)	0.2 ^a
Final path size (cm), median (IQR)	2.0 (0.7–3.2)	1.65 (0.6–4.0)	
Breast density, n (%)			0.8 ^b
Type 1	0	4 (5.6)	
Type 2	2 (28.6)	30 (41.7)	
Type 3	4 (57.1)	26 (36.1)	
Type 4	1 (14.3)	12 (16.7)	
Nuclear grade, n (%)			0.7 ^c
Low	2 (28.6)	18 (25.0)	
Intermediate	3 (42.9)	40 (55.6)	
High	2 (28.6)	14 (19.4)	
Necrosis, n (%)			
Yes	4 (57.1)	45 (62.5)	
No	3 (42.9)	27 (37.5)	

IQR, interquartile range from 25% percentile to 75% percentile; SD, standard deviation.

^a t -test.

^bFisher's exact test, combined 3 and 4.

^cFisher's exact test.

Table 4. Subgroup comparisons of accuracies in subjects with readings in both MRI and mammograph ($N = 60$)

Variable	Groups	<i>n</i>	Test	Accuracy	<i>p</i> -value
Age (years)	≤ 50	19	Mammograph	0.55	0.003
			MRI	0.79	
	> 50	41	Mammograph	0.58	0.8
			MRI	0.59	
Grade	Low	13	Mammograph	0.54	0.9
			MRI	0.53	
	Intermediate	35	Mammograph	0.58	0.03
			MRI	0.71	
	High	12	Mammograph	0.55	0.9
			MRI	0.54	
Necrosis	No	20	Mammograph	0.62	0.3
			MRI	0.73	
	Yes	40	Mammograph	0.52	0.1
			MRI	0.62	
Mammogram density	1–2	28	Mammograph	0.57	0.2
			MRI	0.65	
	3–4	32	Mammograph	0.57	0.1
			MRI	0.67	

MRI), MRI detected 85% of lesions and mammography detected 91% of lesions. This can be explained by the fact that out of the 12 false-negative MRI examinations, 7 cases (58%) demonstrated all the targeted microcalcifications to have been removed during the stereotactic vacuum-assisted biopsy. In these cases, we assumed that no lesions were identified by MRI since most of the pathologies had been removed beforehand during the biopsy. A post-biopsy haematoma obscuring the lesion was also identified in two of the false-negative cases on MRI. Thus, MRI sensitivity in our study was 85% (67/79), which is in the range of prior sensitivities reported in the literature varying from 40% to 100%.^{10,18}

Tumour size in DCIS influences therapeutic decisions. The median DCIS size detected by mammography was smaller

than the median size detected by MRI. This is also supported by the fact that there was a tendency for mammography to underestimate the size of the lesions in a greater number of cases than for MRI (18 underestimated cases at mammography vs 11 underestimated cases at MRI, although not statistically significant). This is in agreement with the notion that mammography detects the calcified portion of DCIS and usually tends to underestimate the size of the lesion.⁸ There was a non-significant tendency for MRI to overestimate the DCIS size in 19 cases (32%). Similar trends have been published with overestimation by MRI seen in up to 50% of cases.^{13,29}

Our study demonstrated that MRI is more accurate than mammography at estimating the size of the lesions when it is

Table 5. Cross-classification of size assessment based on 60 lesions identified at mammography and at breast MRI

Mammography	Breast MRI			
	Underestimation	Accurate estimation	Overestimation	Total (%)
Underestimation	8	9	1	18 (30.0)
Accurate estimation	1	16	8	25 (41.7)
Overestimation	2	5	10	17 (28.3)
Total (%)	11 (18.3)	30 (50.0)	19 (31.7)	60 (100)

Accurate estimation: difference between the imaging and histopathological size of the lesion is ≤ 1 cm; underestimation: imaging underestimates the histopathological size by > 1 cm; overestimation: imaging overestimates the histopathological size by > 1 cm.

seen (accuracy of 0.66 for MRI vs 0.56 for mammography, $p = 0.045$). To our knowledge, five studies^{10,18,30–32} focused on the correlation between the size of DCIS measured at histology and imaging. The first 4 studies evaluated 33, 72, 30 and 22 patients, respectively, and the accuracy of MRI for the size estimation of DCIS ranged from 57% to 72% vs from 38 to 48% for mammography.^{10,18,30,31} In our study, mammography was accurate in 25 cases (42%) and MRI was accurate in 30 cases (50%), which is slightly less than the previously reported accuracy rates. In contrast to the aforementioned publications,^{10,18,30–32} we reported receiver operating characteristic-type accuracy instead of Pearson's correlation because, contrary to Pearson's correlation coefficient, the accuracy estimate has a nice interpretation as a probability. Furthermore, our data on tumour sizes (for MRI, mammography and histopathology) presented skewness and some outliers, which required an approach based on a non-parametric coefficient, such as Obuchowski's method, which uses a modified Kendall's τ .

The last study by Santamaría et al³² demonstrated a correlation coefficient of 0.220 between DCIS size and mammography and a correlation coefficient of 0.439 for the combined use of MRI and mammography compared with histology. These coefficients were not very significant, and the authors challenged the use of MRI in assessing disease extent of DCIS since mammography was more accurate.

MRI can add value in the pre-operative management of DCIS in patients less than 50 years old since its accuracy was higher than that of mammography in this patient subgroup. MRI also showed a better accuracy in lesions of intermediate grade but not in lesions of high grade. This is somewhat in contradiction

with the results of Kuhl et al^{33,34} showing that the sensitivity of mammography decreased with higher nuclear grade, whereas that of MRI increased. Although the studied populations differed (20% vs 53% of high-grade DCIS in our study vs the study by Kuhl et al³³), we expected a better MRI pathological size correlation for the high-grade DCIS.

There are several limitations in our study. First, our study was retrospective in nature and from a single institution and therefore was subject to inevitable selection bias. Second, in our institution, not all females with newly diagnosed cancer were presented to MRI prior to therapeutic decision during the study period, with the decision left at the discretion of the radiologists and surgeons, therefore generating a recruitment bias. Third, there was a relatively small sample size with subgroups, sometimes containing only a few cases. Fourth, the radiologists, reviewing mammograms and MRI, were not blinded to the final pathological outcome. Fifth, pathological size was determined on initial pathological reports, and slides were not reviewed by pathologists for the purpose of this study. Sixth, lesion's size assessment could have been influenced by the fact that vacuum-assisted biopsy have been performed before one imaging modality (breast MRI), generating a bias in imaging and pathological measurements.

In conclusion, MRI was more accurate than mammography in the size assessment of DCIS when the lesion was identified on MRI. When compared with mammography, MRI was a better tool in patients less than 50 years of age. Mammography remains the primary tool for the detection of DCIS, but breast MRI may be used for a more precise pre-operative assessment of tumour size.

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