Supplementary

Table S1 The qualitative and quantitative features of CEM images

Feature	Feature type	Feature category	Source of feature
Breast density*	Qualitative	a	LE images
		b	
		c	
		d	
Lesion type	Qualitative	Presence or absence of mass	LE images
		Presence or absence of calcification	
		Presence or absence of AD	
		Presence or absence of asymmetry	
Enhancement type	Qualitative	Mass enhancement	DES images
		Non-mass enhancement	
Enhancement degree	Qualitative	Mild enhancement	DES images
		Moderate enhancement	
		Marked enhancement	
Degree of BPE*	Qualitative	Minimal	DES images
		Mild	
		Moderate	
		Marked	
Mean lesion density	Quantitative	/	DES images
SD of lesion density	Quantitative	/	DES images
RDE	Quantitative	/	DES images
CNR	Quantitative	/	DES images
RDE/lesion size	Quantitative	/	DES images
CNR/lesion size	Quantitative	/	DES images
Breast thickness (mm)*	Quantitative	/	LE or DES images

*The three features were not included in the statistical analysis. AD, architectural distortion; BPE, background parenchymal enhancement; CEM, contrast-enhanced mammography; CNR, contrast-to-noise ratio; DES, dual-energy subtraction; LE, low energy; RDE, relative degree of enhancement; SD, standard deviation.

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Table S2 The ICCs of the quantitative features of CEM images

Quantitative features	Intraobserver ICC*	Interobserver ICC*
Mean lesion density	0.933	0.902
SD of lesion density	0.706	0.678
RDE	0.917	0.903
CNR	0.819	0.824
RDE/lesion size	0.888	0.830
CNR/lesion size	0.876	0.851

* The intraobserver ICCs of the quantitative features were calculated by the two measurements obtained by the same radiologist. The interobserver ICCs of the quantitative features were calculated by the two measurements obtained by two radiologists. CEM, contrast-enhanced mammography; CNR, contrast-to-noise ratio; ICC, intraclass correlation coefficients; RDE, relative degree of enhancement; SD, standard deviation.

Table S3 The distribution of continuous radiological findings according to expression status of ER, and PR

Continuous variables	ER receptor		P value	PR receptor		P value
	ER+	ER-		PR+	PR-	
Age (year)	51.1±9.6	51.1±7.6	0.987	50.8±9.9	51.5±7.6	0.597
Lesion size (mm)	25.9±13.9	35.0±16.5	0.002	26.8±15.3	31.3±14.9	0.071
Mean lesion density	2095.40±41.20	2095.64±42.08	0.973	2095.93±42.56	2094.76±39.66	0.861
SD of lesion density	23.41±4.39	25.37±5.15	0.027	23.12±4.59	25.34±4.58	0.004
RDE	4.70±2.07	4.80±2.19	0.791	4.72±2.14	4.76±2.06	0.904
CNR	4.07±1.78	3.78±1.56	0.312	4.15±1.85	3.75±1.45	0.141
RDE/lesion size	20.20±8.75	16.48±12.45	0.069	19.96±9.08	17.77±11.43	0.210
CNR/lesion size	17.92±8.95	13.38±8.84	0.004	18.03±9.38	14.34±8.29	0.011

Data are presented as the mean values ± standard deviations. CNR, contrast-to-noise ratio; ER, estrogen receptor; PR, progestogen receptor; RDE, relative degree of enhancement; SD, standard deviation.

Table S4 The distribution of continuous radiological findings according to expression status of HER2, and Ki-67

Continuous variables	HER2 receptor		P value	Ki-67		P value
	HER2-	HER2+		Ki-67-	Ki-67+	
Age (year)	52.0±9.5	48.8±7.5	0.987	52.4±8.7	50.6±9.2	0.267
Lesion size (mm)	27.3±14.6	31.6±16.5	0.002	32.4±21.0	27.3±12.5	0.148
Mean lesion density	2095.96±42.40	2094.30±39.06	0.973	2102.34±48.31	2093.02±38.47	0.269
SD of lesion density	23.85±4.53	24.33±5.12	0.027	25.32±4.81	23.52±4.59	0.040
RDE	4.73±2.15	4.73±2.01	0.791	5.14±2.48	4.59±1.94	0.207
CNR	4.02±1.81	3.92±1.51	0.312	4.03±1.88	3.87±1.67	0.862
RDE/lesion size	19.28±8.78	18.70±12.78	0.069	19.53±11.22	18.95±9.70	0.770
CNR/lesion size	16.83±8.76	16.00±10.01	0.004	16.35±11.23	16.67±8.30	0.867

Data are presented as the mean values ± standard deviations. CNR, contrast-to-noise ratio; HER2, human epidermal growth factor receptor 2; RDE, relative degree of enhancement; SD, standard deviation.

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Table S5 The correlation between categorical radiological findings and expression status of ER, and PR

Categorical variables	ER+	ER-	φ	P value	PR+	PR-	φ	P value
Mass			0.109	0.172			0.019	0.817
Present	77/110 (70.0)	27/46 (58.7)			64/95 (67.4)	40/61 (65.6)		
Absent	33/110 (30.0)	19/46 (41.3)			31/95 (32.6)	21/61 (34.4)		
Calcification			0.075	0.348			0.159	0.046
Present	46/110 (41.8)	23/46 (50.0)			36/95 (37.9)	33/61 (54.1)		
Absent	64/110 (58.2)	23/46 (50.0)			59/95 (62.1)	28/61 (45.9)		
Architectural distortion			0.280	<0.001			0.324	<0.001
Present	29/110 (26.4)	1/46 (2.2)			28/95 (29.5)	2/61 (3.3)		
Absent	81/110 (73.6)	45/46 (97.8)			67/95 (70.5)	59/61 (96.7)		
Asymmetry			0.118	0.139			0.081	0.314
Present	10/110 (9.1)	8/46 (17.4)			9/95 (9.5)	9/61 (14.8)		
Absent	100/110 (90.9)	38/46 (82.6)			86/95 (90.5)	52/61 (85.2)		
Enhancement degree*			0.059[a]	0.910			0.118[a]	0.536
Mild	34/109 (31.2)	15/46 (32.6)			33/94 (35.1)	16/61 (26.2)		
Moderate	24/109 (22.0)	9/46 (19.6)			18/94 (19.1)	15/61 (24.6)		
Marked	51/109 (46.8)	22/46 (47.8)			43/94 (45.7)	30/61 (49.2)		
Enhancement type*			0.197	0.014			0.032	0.692
Mass	85/109 (78.0)	19/46 (41.3)			69/94 (73.4)	43/61 (70.5)		
Non-mass	24/109 (22.0)	27/46 (58.7)			25/94 (26.6)	18/61 (29.5)		

Data are shown as proportions with percentages in parentheses; * Lesions with no enhancement are not shown in this table; [a] Cramer's V (φ) was provided for association between two categorical variables; ER, estrogen receptor; PR, progestogen receptor.

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Table S6 The correlation between categorical radiological findings and expression status of HER2, and Ki-67

Categorical variables	HER2-	HER2+	φ	P value	Ki-67-	Ki-67+	φ	P value
Mass			0.258	0.001			0.041	0.607
Present	82/110 (74.5)	22/46 (47.8)			26/41 (63.4)	78/115 (67.8)		
Absent	28/110 (25.5)	24/46 (52.2)			15/41 (36.6)	37/115 (32.2)		
Calcification			0.217	0.007			0.239	0.003
Present	41/110 (37.3)	28/46 (60.9)			10/41 (24.4)	59/115 (51.3)		
Absent	69/110 (62.7)	18/46 (39.1)			31/41 (75.6)	56/115 (48.7)		
Architectural distortion			0.209	0.009			0.115	0.150
Present	27/110 (24.5)	3/46 (6.5)			11/41 (26.8)	19/115 (16.5)		
Absent	83/110 (75.5)	43/46 (93.5)			30/41 (73.2)	96/115 (83.5)		
Asymmetry			0.206	0.010			0.079	0.324
Present	8/110 (7.3)	10/46 (21.7)			3/41 (7.3)	15/115 (13.0)		
Absent	102/110 (92.7)	36/46 (78.3)			38/41 (92.7)	100/115 (87.0)		
Enhancement degree*			0.055[a]	0.924			0.149[a]	0.323
Mild	34/109 (31.2)	15/46 (32.6)			11/40 (27.5)	38/115 (33.0)		
Moderate	23/109 (21.1)	10/46 (21.7)			8/40 (20.0)	25/115 (30.4)		
Marked	52/109 (47.7)	21/46 (45.7)			21/40 (52.5)	52/115 (45.2)		
Enhancement type*			0.165	0.040			0.194	0.016
Mass	84/109 (77.1)	28/46 (60.9)			23/40 (57.5)	89/115 (77.4)		
Non-mass	25/109 (22.9)	18/46 (39.1)			17/40 (42.7)	26/115 (22.6)		

Data are shown as proportions with percentages in parentheses; * Lesions with no enhancement are not shown in this table; [a] Cramer's V (φ) was provided for association between two categorical variables; HER2, human epidermal growth factor receptor 2.

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Table S7 Multivariate logistic regression analysis between radiological findings and expression status of ER, and PR

Independent variables	Dependent variables							
	ER– *vs.* ER+				PR– *vs.* PR+			
	OR (95% CI)	P value	OR_{ad} (95% CI)*	P value*	OR (95% CI)	P value	OR_{ad} (95% CI)*	P value*
Lesion size (mm)	0.96 (0.94–0.99)	0.002	0.96 (0.94–0.99)	0.005	0.98 (0.96–1.00)	0.079	0.98 (0.96–1.01)	0.142
SD of lesion density	0.91 (0.84–0.99)	0.021	0.93 (0.86–1.01)	0.084	0.90 (0.83–0.97)	0.006	0.90 (0.83–0.98)	0.015
RDE/lesion size	1.05 (1.00–1.09)	0.036	1.04 (1.00–1.09)	0.046	1.02 (0.99–1.06)	0.191	1.02 (0.99–1.06)	0.203
CNR/lesion size	1.07 (1.02–1.12)	0.006	1.07 (1.01–1.12)	0.011	1.05 (1.01–1.10)	0.016	1.05 (1.01–1.09)	0.026
Presence of calcification	0.72 (0.36–1.43)	0.349	0.70 (0.34–1.44)	0.337	0.52 (0.27–0.99)	0.048	0.51 (0.26–0.99)	0.047
Presence of architectural distortion	16.11 (2.12–122.24)	0.007	19.98 (2.56–156.30)	0.004	12.33 (2.82–53.97)	0.001	14.69 (3.25–66.38)	0.000
Enhancement type	0.40 (0.19–0.84)	0.016	0.43 (0.20–0.93)	0.031	0.87 (0.42–1.77)	0.692	0.93 (0.44–1.95)	0.846

* The ORs_{ad} and P values were adjusted for age, breast thickness and breast density, CI, confidence interval; CNR, contrast-to-noise ratio; ER, estrogen receptor; OR, odds ratio; PR, progestogen receptor; RDE, relative degree of enhancement; SD, standard deviation.

Table S8 Multivariate logistic regression analysis between radiological findings and expression status of HER2, and Ki-67

Independent variables	Dependent variables							
	HER2– *vs.* HER2+				Ki-67– *vs.* Ki-67+			
	OR (95% CI)	P value	OR_{ad} (95% CI)*	P value*	OR (95% CI)	P value	OR_{ad} (95% CI)*	P value*
Lesion size (mm)	1.02 (1.00–1.04)	0.119	1.02 (0.99–1.04)	0.171	0.98 (0.96–1.00)	0.074	0.98 (0.96–1.00)	0.066
SD of lesion density	1.02 (0.95–1.10)	0.563	1.00 (0.93–1.08)	0.938	0.92 (0.85–1.00)	0.039	0.91 (0.84–0.99)	0.026
RDE/lesion size	0.99 (0.96–1.03)	0.743	0.99 (0.96–1.03)	0.719	0.99 (0.96–1.03)	0.752	0.99 (0.96–1.03)	0.740
CNR/lesion size	0.99 (0.95–1.03)	0.602	0.99 (0.95–1.03)	0.742	1.00 (0.96–1.04)	0.846	1.00 (0.97–1.05)	0.813
Presence of calcification	2.62 (1.29–5.31)	0.008	2.57 (1.24–5.32)	0.011	3.27 (1.47–7.28)	0.004	3.24 (1.44–7.29)	0.005
Presence of architectural distortion	0.21 (0.06–0.75)	0.016	0.19 (0.05–0.67)	0.010	0.54 (0.23–1.26)	0.154	0.52 (0.22–1.22)	0.134
Enhancement type	2.16 (1.03–4.53)	0.042	1.97 (0.92–4.22)	0.082	0.40 (0.18–0.85)	0.017	0.36 (0.16–0.79)	0.012

* The ORs_{ad} and P values were adjusted for age, breast thickness and breast density; CI, confidence interval; CNR, contrast-to-noise ratio; HER2, human epidermal growth factor receptor 2; OR, odds ratio; RDE, relative degree of enhancement; SD, standard deviation.

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