

# 가 : BI-RADS

: BI-RADS  
 : 2 60  
 , 4 가  
 , , 가  
 : ( =0.65) ( =0.61) 가  
 ( =0.42) 가 ( =0.46) ( =0.49)  
 가 ( =0.62, 0.57) ( =0.90, 0.82) ( =0.87, 0.83)  
 가 ( =0.59, 0.65) 가  
 : BI-RADS ( =0.65 - 0.83).

가 BI-RADS

(consistency) (reproducibility) (18). 가 가 (operator - dependant)

(American College of Radiology) Breast Imaging 가 , BI-RADS  
 Reports and Data System (BI-RADS)

(description) 가 (19).

가 (1 - 3). BI -

RADS

(inter - and intraobserver variability)

(4 - 16).

가

가

(observer variability)

(4 - 12),

가

BI-RADS

가

BI-RADS

가

(17)

가

(13 - 16). 2003 ACR BI-RADS

(lexicon)가

1  
2  
3

2006 5 17

2007 3 29

2004 7 10

125

(gun biopsy)

가 25 , 가 100 . 25 4c  
 1 35  
 60  
 . 36 (n=35), (n=1)  
 24 (screening)  
 가  
 60 20 가 4  
 1 59  
 (Senographe 600T; GE medical systems, Waukesha, Wis, U.S.A.)  
 BI - RADS  
 1 7 , 2 8 , 3 21 , 4 23 . 34  
 (n=25),  
 (n=5), (n=3),  
 (n=1) 25  
 가 5 - 12 MHz  
 (HDI 5000; Advanced Technology Laboratories, Bothell, Wash, U.S.A.)  
 9  
 mm 4 , 10 - 19 mm 28 , 20 - 29 mm 16 , 30 mm  
 12 (gray - scale images) (caliper)가  
 1 BMP  
 35 (fibrocystic change; n=22), (fibroadenoma; n=12),  
 (intraductal papilloma; n=1) , 25  
 (invasive ductal cancer; n=18), (ductal carcinoma in situ; n=2), (papillary carcinoma; n=2),  
 (metaplastic carcinoma; n=1), (invasive lobular cancer; n=1), (intraductal papillary carcinoma; n=1)  
 2  
 3 20 ,  
 , BI - RADS  
 (2048 x 2059 pixels) CRT  
 BI - RADS  
 (shape),  
 (orientation), (margin), (lesion boundary),  
 (echo pattern), (posterior acoustic feature)  
 (Table 1). 가 (final assessment category)  
 category 2 - 5  
 (surrounding tissue), (special cases),  
 (vascularity) 가 category 4 4a, 4b,

BI - RADS 가  
 BI - RADS  
 (rates of agreement) kappa  
 (Cohen 's kappa statistics) (20).  
 가 가 kappa  
 : ?? 0.20, (slight) ; 0.21 - 0.40,  
 (fair) ; 0.41 - 0.60, (moderate) ; 0.61 -  
 0.80, (substantial) ; 0.81 - 1.00,  
 (almost perfect agreement). 가 category 2  
 3 , category 4 5  
 가 (even

**Table 1.** ACR BI-RADS US Lexicon, Simplified for This Study

1. Masses	
Shape	Oval Round Irregular
Orientation	Parallel Not parallel
Margin	Circumscribed Not circumscribed Indistinct Angular Microlobulated Spiculated
Lesion boundary	Abrupt interface
Echo pattern	Echogenic halo Anechoic Hyperechoic Complex Hypoechoic Isoechoic
Post. acoustic features	No posterior acoustic features Enhancement Shadowing Combined pattern
2. Calcifications	
If present	Macrocalcifications Microcalcifications out of mass Microcalcifications in mass
3. Final assessment category	
Category 2: benign finding	
Category 3: probably benign finding	
Category 4: suspicious abnormality	
Category 5: highly suggestive of malignancy	

distribution) 가  
 kappa (negative value)  
 (kappa paradox) (21, 22).  
 kappa (standard error)  
 (overall proportion of agreement) (positive  
 agreement+negative agreement/total number) 95%  
 (confidence interval; , CI) (23).  
 overall proportion of agreement kappa  
 가 .  
 kappa proportion of  
 agreement 가 , ,  
 SPSS  
 version 10 for Windows (SPSS Inc., Chicago, Ill)

(abrupt interface) 43.3%  
 (echogenic halo) 가  
 . , , 가  
 (anechoic) .  
 , , .  
 가 가 가  
 가 (=0.46) (=0.49)  
 가 가  
 가 가 가

(Table 2, 3)

BI - RADS ( =0.42 - 0.65)  
 (Table 2). ( =0.65), ( =0.61), ( =0.49), ( =0.47), ( =0.44),  
 (overall proportion of agreement=0.43),  
 ( =0.42) 가 .  
 가 ( =0.61) ( =0.65) .  
 (Table 3) 가  
 가 ( =0.42 - 0.49)  
 (circumscribed), (microlobu -  
 lated), (indistinct)  
 (spiculated) (angular)  
 가 .

(Table 4, 5)

BI - RADS ( =0.57 - 0.90)  
 (Table 4). ( =0.90, 0.82)  
 ( =0.87, 0.83) 2 가  
 , ( =0.77, 0.74) ( =0.71,

Table 3. Proportion of Agreement between Readers for Detailed Items of Descriptors

		POA(%)	95% CI
Shape	Oval	61.3	42.2 - 77.6
	Round	44.4	15.3 - 77.4
	Irregular	67.7	49.4 - 82.0
Orientation	Parallel	75.6	59.4 - 87.1
	Not parallel	65.5	45.7 - 81.4
Margin	Circumscribed	66.7	47.1 - 82.1
	Indistinct	35.7	19.3 - 55.9
	Angular	0	
	Microlobulated	36.8	17.2 - 61.4
Lesion boundary	Spiculated	0	
	Spiculated	0	
	Abrupt interface	43.3	30.8 - 56.7
Echo pattern	Echogenic halo	0	
	Anechoic	N/A	N/A
Post. acoustic features	Hyperechoic	0	
	Complex	20.0	1.1 - 70.1
	Hypoechoic	78.9	64.9 - 88.5
	Isoechoic	30.8	10.4 - 61.1
	No post feature	59.1	43.3 - 73.3
Microcalcifications	Enhancement	50.0	28.8 - 71.2
	Shadowing	40.0	7.3 - 83.0
	Combined pattern	11.1	0.6 - 49.3
Final assessment	In mass (-)	85.5	72.8 - 93.1
	In mass (+)	38.5	15.1 - 67.7
Management	Category 2, 3	52.9	4.0 - 72.6
	Category 4, 5	61.9	32.3 - 68.4
Patient management	Biopsy	61.9	45.7 - 76.0
	F/U	52.9	35.4 - 69.8

Table 2. Interobserver Agreement for BI-RADS US Lexicon for 60 Solid Breast Masses

BI-RADS descriptors	value (SE)
Shape	0.61 (0.09)
Orientation	0.65 (0.10)
Margin	0.47 (0.09)
Lesion Boundary	0.43 (- 0.49, - 0.20)*
Echo Pattern	0.44 (0.12)
Posterior Acoustic Features	0.42 (0.10)
Microcalcifications in mass	0.49 (0.15)
BI-RADS final assessment category	0.46 (0.13)
Patient management	0.49 (0.09)

Note. SE: standard errors  
 \* overall proportion of agreement with 95% confidence interval

Note. POA: proportion of agreement  
 CI: confidence interval  
 N/A: no account

0.72) 2  
 (=0.70, 0.57), (=0.62, 0.57),  
 =0.59, 0.65) 가  
 가 가 2  
 5). 가 2 가 (Table 가 2  
 가

**Table 4.** Intraobserver Agreement for BI-RADS US Lexicon for 60 solid Breast Masses

	Reader 1	Reader 2
BI-RADS descriptors		
Shape	0.77 (0.08)	0.74 (0.08)
Orientation	0.87 (0.07)	0.83 (0.07)
Margin	0.71 (0.07)	0.72 (0.07)
Lesion Boundary	0.70 (0.09)	0.57 (0.14)
Echo Pattern	0.62 (0.10)	0.57 (0.14)
Posterior Acoustic Features	0.59 (0.09)	0.65 (0.10)
Microcalcifications in mass	0.90 (0.07)	0.82 (0.13)
BI-RADS final assessment category	0.72 (0.09)	0.65 (0.08)
Patient management	0.83 (0.08)	0.77 (0.08)

Note. SE: standard errors

**Table 5.** Proportion of Agreement Within the Reader for Detailed Items of Descriptors

		Reader 1		Reader 2	
		POA(%)	95% CI	POA(%)	95% CI
Shape	Oval	77.3	54.2 - 91.3	70.0	50.4 - 84.6
	Round	62.5	25.9 - 89.8	71.4	30.3 - 94.9
	Irregular	79.0	62.2 - 89.9	78.1	59.6 - 90.1
Orientation	Parallel	88.6	72.3 - 96.3	87.2	71.8 - 95.2
	Not parallel	86.2	67.4 - 95.5	80.8	60.0 - 92.7
Margin	Circumscribed	76.9	55.9 - 90.3	71.4	51.1 - 86.1
	Indistinct	71.4	47.7 - 87.8	63.6	40.8 - 82.0
	Angular	0		25.0	1.3 - 78.1
Lesion boundary	Microlobulated	61.9	38.7 - 81.1	73.3	44.8 - 91.1
	Spiculated	0		66.7	12.5 - 98.2
	Abrupt interface	76.3	59.4 - 88.0	87.0	74.5 - 94.2
Echo pattern	Echogenic halo	71.0	51.8 - 85.1	46.2	20.4 - 73.9
	Anechoic	N/A		N/A	
	Hyperechoic	50.0	9.2 - 90.8	0	
	Complex	50.0	14.0 - 86.1	33.3	1.8 - 87.5
Post. features	Hypoechoic	83.3	69.2 - 92.0	84.9	71.9 - 92.8
	Isoechoic	41.7	16.5 - 71.4	50.0	22.3 - 77.7
	No feature	64.1	47.2 - 78.3	78.3	63.2 - 88.6
	Enhancement	56.5	34.9 - 76.1	66.7	41.2 - 85.6
Microcalcifications	Shadowing	40.0	7.3 - 83.0	25.0	1.3 - 78.1
	Combined pattern	62.5	25.9 - 89.8	50.0	26.6 - 97.3
	In mass (-)	95.9	84.9 - 99.3	96.4	86.4 - 99.4
Final assessment	In mass (+)	84.6	53.7 - 97.3	71.4	30.3 - 94.9
	Category 2, 3	77.8	38.6 - 87.5	85.3	36.9 - 87.2
Management	Category 4, 5	91.3	68.0 - 92.5	83.9	57.3 - 88.4
	Biopsy	91.3	78.3 - 97.2	78.1	59.7 - 90.1
	F/U	77.8	51.9 - 92.6	80.0	62.5 - 90.0

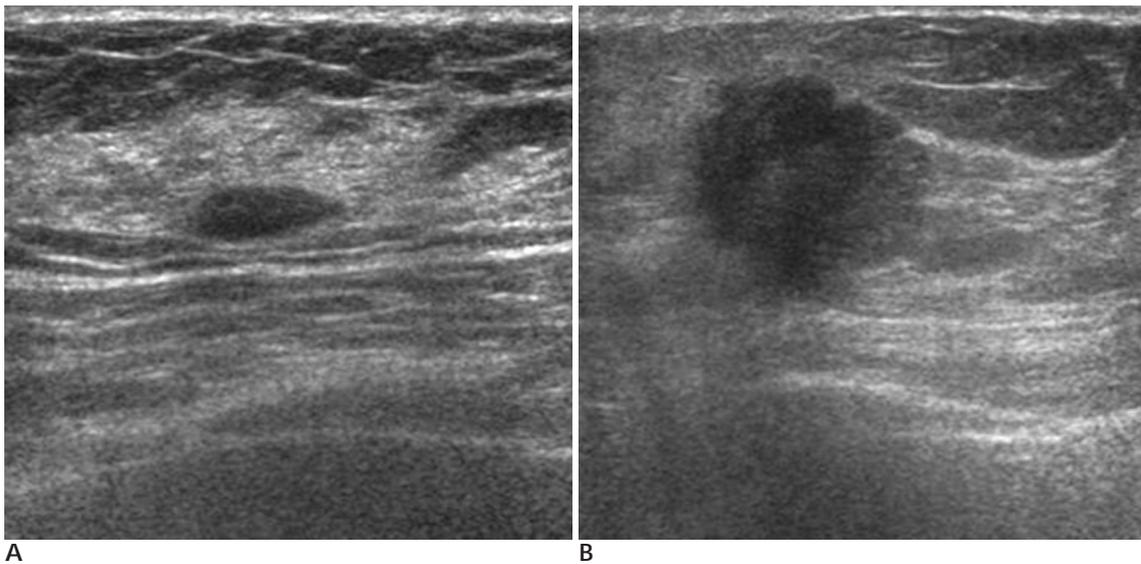
Note. POA: proportion of agreement  
 CI: confidence interval  
 N/A: no account

( $\kappa = 0.72$ ,  $\kappa = 0.65$ ) 가 .

( $\kappa = 0.65 - 0.83$ ) ( $\kappa = 0.83$ , (1 - 16, 19) (perception,  
 $\kappa = 0.77$ ) 가 . detection) (interpretation,  
 가 . characterization) 가 (7).  
 가 ,

100%, 92.0% 44.3%, 80.0% 가 가  
 (positive predictive value) 56.2% 76.7% (2, 8) 가  
 , (negative predictive value) 100% 가  
 93.3% 가

가  
 2 (Fig. 1). 3 , 가 BI - RADS  
 가 가 (Fig. 2), 2 가  
 가 1 (Fig. BI - RADS  
 3). 가 가 ( = 0.42 - 0.65),  
 3 1  
 가 가 가  
 가 가 가  
 가 , 가 ( = 0.57 - 0.90). 가  
 가 가 가 ( = 0.46 - 0.49),  
 가 가 가 ( = 0.65 - 0.83).  
 가 가 가 BI - RADS 가  
 가 가 가 가 (5, 14).



**Fig. 1.** Two cases showing complete inter- and intraobserver agreement in both the description and the final assessment category.  
**A.** Transverse sonogram in a 46-year-old woman living a screening-detected mass. Both observers agreed completely; oval shape, parallel orientation, circumscribed margin, abrupt interface of lesion boundary, hypoechoic echo pattern, no posterior acoustic features and no calcification; category 2 requiring routine follow-up. This case was confirmed as fibrocystic change.  
**B.** Longitudinal sonogram in a 74-year-old woman with a palpable mass. Both observers agreed completely; irregular shape, not parallel orientation, microlobulated margin, abrupt interface of lesion boundary, hypoechoic echo pattern, no posterior acoustic feature, and no calcification; category 4 requiring biopsy. Pathologic result of gun biopsy revealed invasive ductal carcinoma.

(14, 19). Baker (14) Stavros (17)가

가

( =0.51; =0.63)

( =0.40 - 0.80),

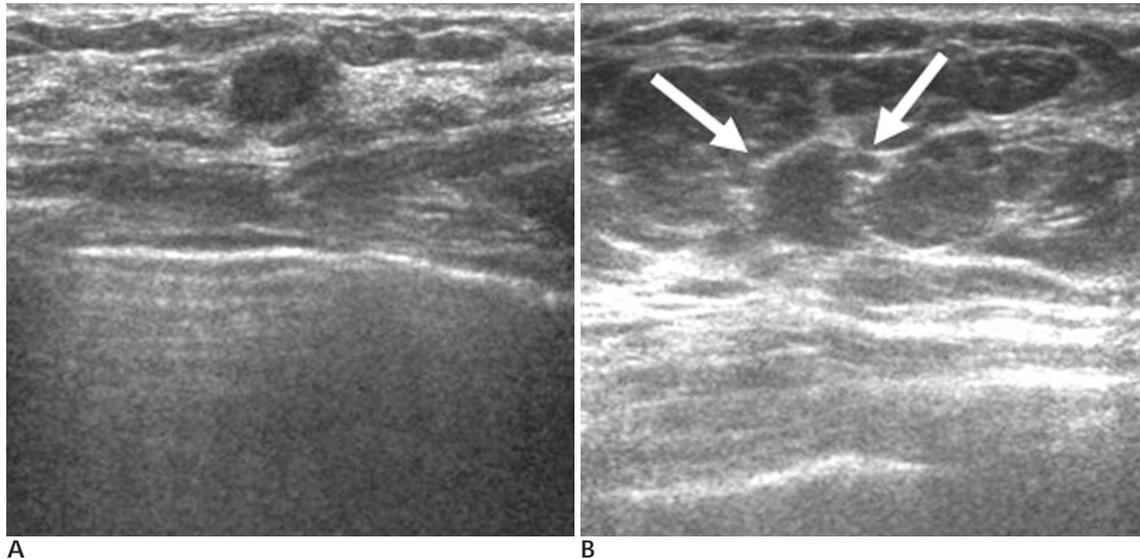
( =0.62 - 0.79).

가

. Lazarus (19) BI-

RADS

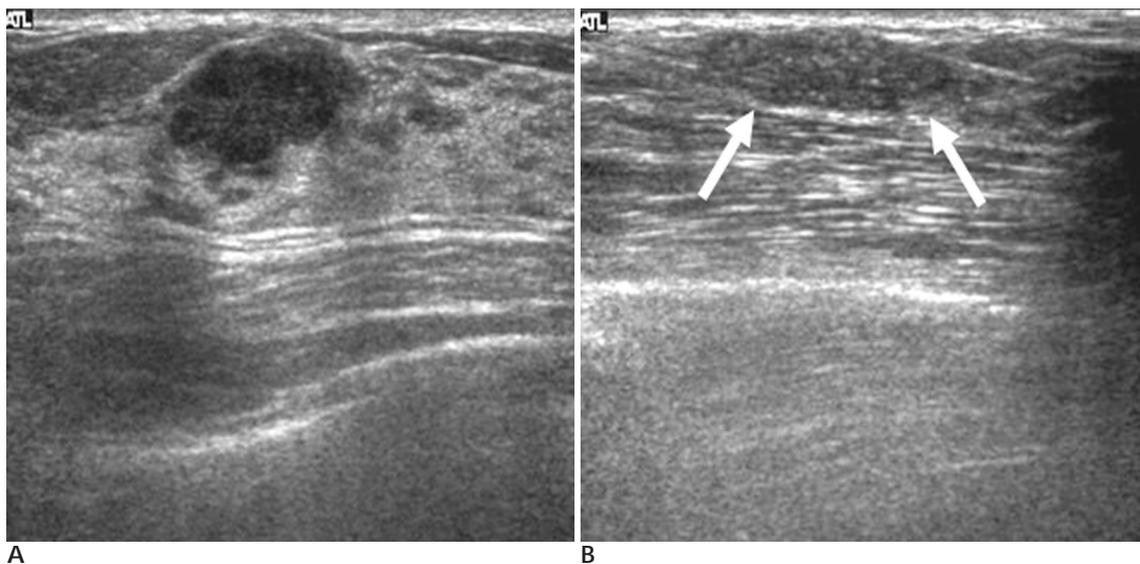
가



**Fig. 2.** Two malignant cases showing the interobserver variability.

**A.** Transverse sonogram in a 46-year-old woman having a screening-detected mass. Both observers agreed on the description of the mass completely; oval shape, parallel orientation, microlobulated margin, abrupt interface of lesion boundary, hypoechoic echo pattern, no posterior acoustic feature, and no calcification. One observer assessed the mass as category 4 and the other as category 3. Pathologic result of gun biopsy revealed invasive ductal carcinoma.

**B.** Transverse sonogram in a 41-year-old woman having a screening-detected mass (arrows). One reader described the mass as having an irregular shape and microlobulated margin and assessed as category 4. The other described the mass as having an irregular shape and indistinct margin, but assessed as category 3. This case was confirmed as invasive ductal carcinoma.



**Fig. 3.** Two malignant cases showing the intraobserver variability.

**A.** Transverse sonogram in a 38-year-old woman with a palpable mass, confirmed as invasive ductal carcinoma. One reader initially described the mass as having an oval shape with final assessment of category 3. But 4 weeks later, the reader described the mass as having an irregular shape with final assessment of category 4.

**B.** Transverse sonogram in a 36-year-old woman with a palpable mass, confirmed as ductal carcinoma in situ. One reader initially described the mass as having an indistinct margin with final assessment of category 3. Four weeks later, the reader described the mass as having a circumscribed margin with final assessment of category 4.

( =0.29 - 0.69), 가  
( =0.28), 가  
( =0.45). 가  
category 4 subcategory가 RADS 가 ACR BI -  
BI - RADS 가 가  
(k=0.41 - 0.60) BI - RADS 0.83) Lazarus (19) 가 (k=0.46 - 0.72 vs. k=0.49 -  
가 ( =0.28 vs. =0.45).  
(2, 14, 17) 가 0.61, 0.47, 0.43 가  
(100% vs. 92.0%)  
(80.0% vs. 44.3%)  
(proportion of agreement)가 67.7%  
가  
가 가 50%  
가 가  
가 (14, 19).  
(descriptor)  
가 가 가  
(2, 14, 17) 가 가  
BI - RADS Berg (8)  
category  
(8, 9, 24, 25).  
( =0.65 - BI - 가  
0.87 vs. k=0.61). RADS 가 (true)  
( =0.49 - 가  
0.90). 가  
category 2  
( =0.42 - 0.65 vs. =0.40 - 0.69) 4  
(2, 14, 17) , BI - RADS  
가



## Breast Imaging Reporting and Data System (BI-RADS) US lexicon and Final Assessment Category for Solid Breast Masses: the Rates of Inter- and Intraobserver Agreement<sup>1</sup>

Eun Hye Lee, M.D., Joo Hee Cha, M.D., Byung Jae Cho, M.D.<sup>2</sup>, Young Hwan Koh, M.D.,  
Byung Jae Youn, M.D., Woo Kyung Moon, M.D.<sup>3</sup>

<sup>1</sup>Department of Radiology, Seoul Municipal Boramae Hospital

<sup>2</sup>Department of Radiology, Cheil General Hospital & Women's Healthcare Center

<sup>3</sup>Department of Radiology and Clinical Research Institute, Seoul National University Hospital

**Purpose:** To evaluate the rates of inter- and intraobserver agreement of the BI-RADS US lexicon.

**Materials and Methods:** Two radiologists reviewed 60 sonograms of solid breast masses to evaluate interobserver agreement. After four weeks, the radiologists reinterpreted the series to evaluate the intraobserver agreement. The radiologists described shape, orientation, margin, lesion boundary, echo pattern, posterior acoustic features and microcalcifications. Final assessment categories and management plans were suggested for each case. The rates of inter- and intraobserver agreements were measured by the use of kappa statistics.

**Results:** Interobserver agreement ranged from the highest for orientation ( $\kappa = 0.65$ ) and shape ( $\kappa = 0.61$ ) to the lowest for posterior acoustic features ( $\kappa = 0.42$ ). For the final assessment categories ( $\kappa = 0.46$ ) and management ( $\kappa = 0.49$ ), interobserver agreements were moderate. Intraobserver agreement ranged from the highest for microcalcifications in mass ( $\kappa = 0.90, 0.82$ ) and orientation ( $\kappa = 0.87, 0.83$ ) and the lowest for echo patterns ( $\kappa = 0.62, 0.57$ ) and posterior acoustic features ( $\kappa = 0.59, 0.65$ ). In the final assessment category and management, intraobserver agreements were substantial or nearly complete ( $\kappa = 0.65 - 0.83$ ).

**Conclusion:** There were variable ranged inter- and intraobserver agreements in the description of the BI-RADS US lexicon of solid breast masses. Among them, margin and lesion boundary showed lower agreements. A modification of the BI-RADS US lexicon with more detailed guidelines, followed by continuous education, are suggested.

**Index words :** Breast, US  
Breast neoplasms, US  
Images, interpretation  
Ultrasound (US), quality assurance

Address reprint requests to : Byung Jae Cho, M.D., Department of Radiology, Cheil General Hospital & Women's Healthcare Center  
1-19, Mookjung-dong, Chung-gu, Seoul 100-380, Korea.  
Tel. 82-2-2000-7382 Fax. 82-2-2000-7389 E-mail: bj31.cho@cgh.co.kr