

(conventional US)  
(pulse inversion harmonic US)  
(real-time compound US)

1

: ,  
: 22 ( 9 , 10 ,  
3 ) ,  
49 . 가 3가  
1. 2. 3.  
4. 5. 6.  
(12/22) 7. 3가  
가 . 1. 5. (6/22)  
: Friedman's test  
, 가  
, (p< 0.05).  
:

(dynamic range) ,  
(frame rate) 가 (2).  
,  
(real time frame rate)  
(1). 가 가 ,  
, 가 가 ,  
,

2000 5 2001 9  
,  
(1). 22 , 가  
10 , 3 9 ,  
23 64  
49 .

Laboratories, Bothell, Washington) (broad  
bandwidth) 가 12 - 5MHz 50 mm

1 가

3  
survey mode ,  
9  
target mode 2

가 survey mode  
2 1.  
3.  
4. 5.  
5가 가

가 가 . 1 5 5  
Friedman 's test . 6.  
(12/22) 7. (6/22) 2가  
가 .  
7가 1 3

**Table 1.** Grades of Imaging Technique Regarding Sonographic Features

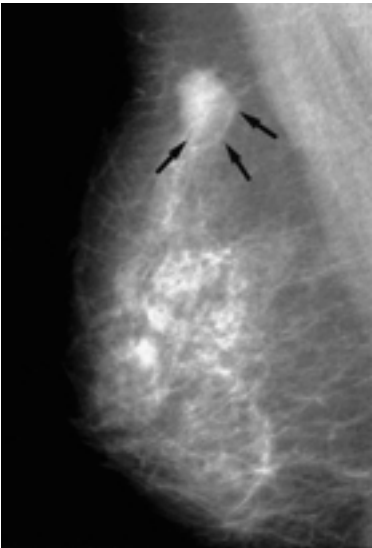
		RCUS	CUS	PIHI
1.	Grade 3	22	0	0
	* Grade 2	0	21	1
	Grade 1	0	1	21
2.	Grade 3	21	2	0
	* Grade 2	1	20	1
	Grade 1	0	0	21
3.	Grade 3	21	1	0
	* Grade 2	1	21	0
	Grade 1	0	0	22
4.	Grade 3	14	2	3
	* Grade 2	6	14	4
	Grade 1	2	6	15
5.	Grade 3	20	0	0
	* Grade 2	1	22	0
	Grade 1	1	0	22
6.	Grade 3	9	3	0
	(12/22) Grade 2	3	9	0
	Grade 1	0	0	12
7.	Grade 3	3	1	2
	(6/22) Grade 2	0	5	1
	Grade 1	3	0	3

RCUS Real-time compound US

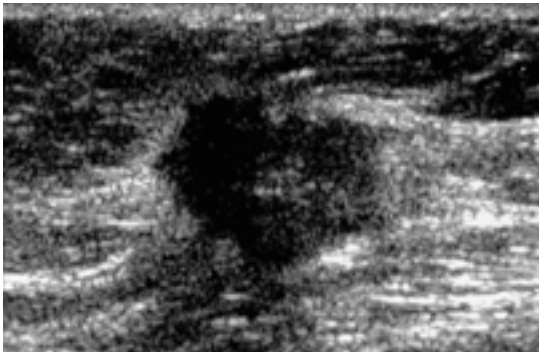
CUS Conventional US

PIHI Pulse inversion harmonic image

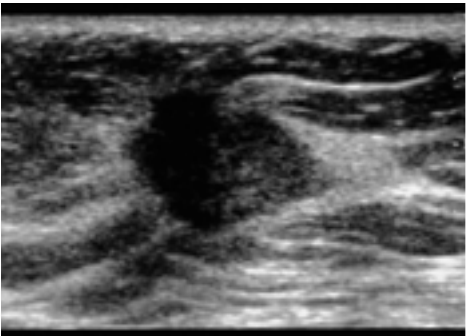
\* Statistically significant ( $p < 0.05$ ) in factors 1 - 5  
(by Friedman 's test)



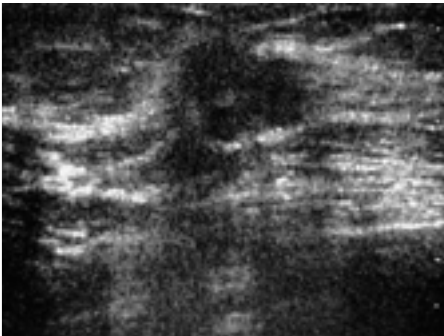
**A**



**B**



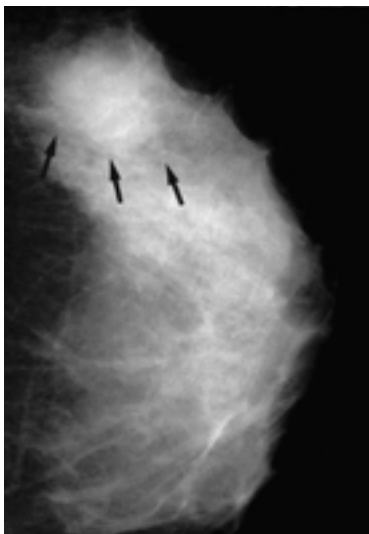
**C**



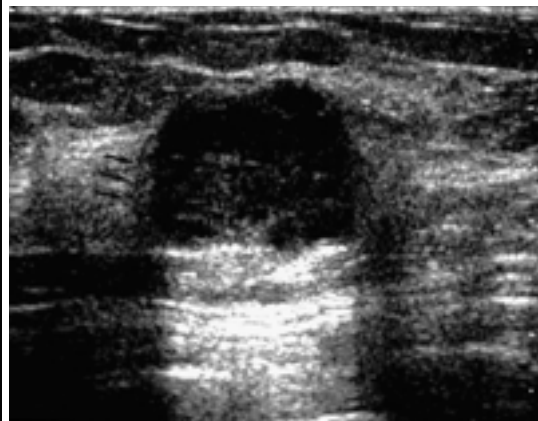
**D**

**Fig. 1.** Invasive ductal carcinoma in right breast in a 54 -year-old woman.  
**A.** Mediolateral oblique mammogram shows a 2 × 1.5 cm size mass with spiculated margin (arrows) in right upper outer breast.  
**B.** CUS shows a hypoechoic mass with angular margin in right breast.  
**C.** RCUS shows more distinctive margin of the mass than that of CUS.  
**D.** PIHI shows relatively poor margin of mass, but posterior margin of the mass is relatively clear.

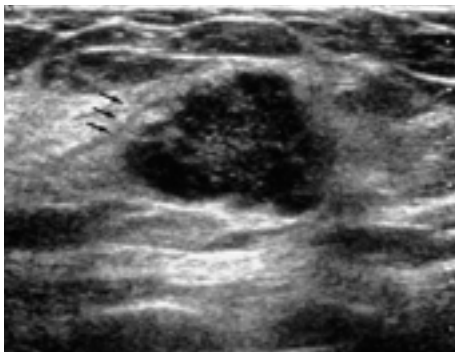
가 3 , 가 (Fig. 3)  
 1 . (Fig. 4) 가  
 . 가 ( $p < 0.05$ ). 가 22  
 12 (Fig. 5) 가  
 6 가  
 2 가 가  
 7가 가  
 (Table 1). 가  
 grade 3 22 , grade 2가 0 , grade 1 0  
 grade 3 0 , grade 2가 1 , grade 1  
 21 grade 3 0 , grade 2가  
 21 , grade 1 1 ( $p < 0.05$ ) (Fig. 1). 가  
 grade 3 21 가 , grade  
 1 21 , grade 2가 20 ( $p < 0.05$ ). 가  
 가 8G 11G  
 90% 가 (9).  
 ( $p < 0.05$ ) (Fig. 2).



A



B

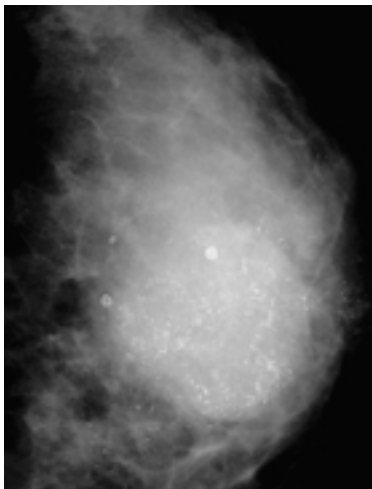


C

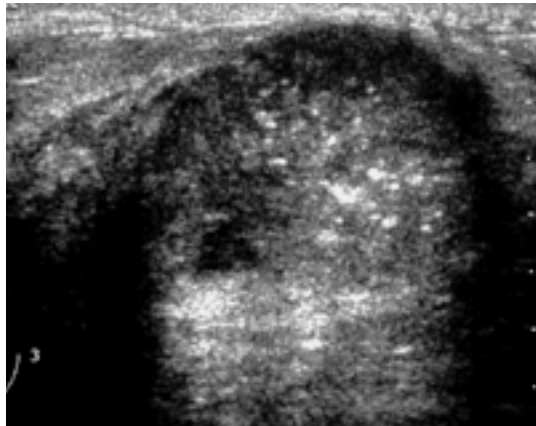


D

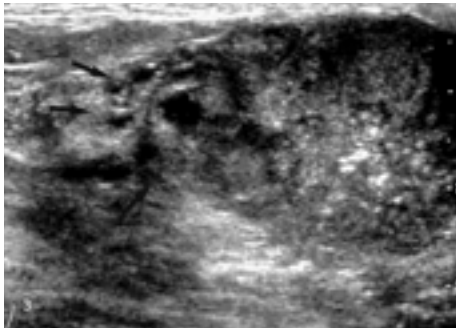
**Fig. 2.** Invasive ductal carcinoma in left breast in a 57-year-old woman.  
**A.** Craniocaudal mammogram shows a 2.5 × 1.5 cm size lobular mass in lateral aspect of left breast.  
**B.** CUS shows a hypoechoic mass with microlobulated border (arrows).  
**C.** RCUS shows a more distinctive boundary echo pattern of the mass (arrows).  
**D.** PIHI shows a relatively poor margin of the mass.



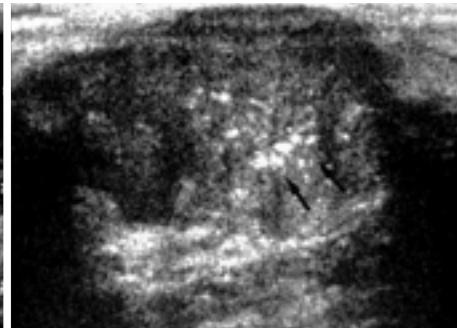
**A**



**B**



**C**



**D**

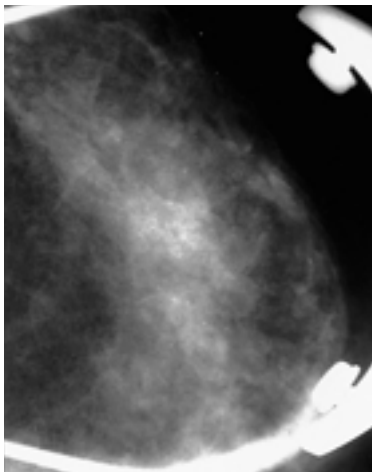
**Fig. 3.** Invasive ductal carcinoma in right breast in a 55-year-old woman.

**A.** Craniocaudal mammogram shows a 5 × 5 cm size ovoid mass with partially obscured margin with pleomorphic microcalcifications in right upper outer breast.

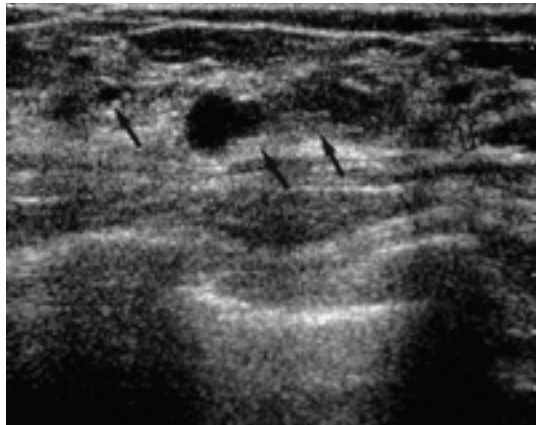
**B.** CUS shows a heterogeneous hypoechoic mass with multiple internal echogenic foci by microcalcifications.

**C.** RCUS shows also heterogeneous hypoechoic mass. Inhomogeneous internal echogenicity of the mass and clear distinction between the mass and adjacent lactiferous ducts (arrows) are demonstrated. But posterior acoustic shadow by calcifications is demonstrated poorer than that of CUS.

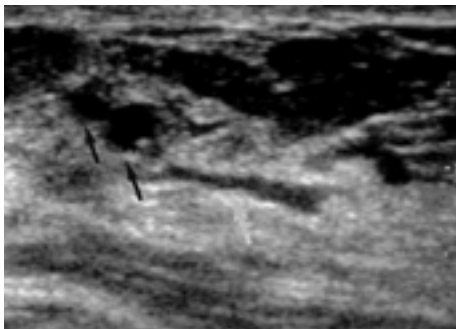
**D.** PIHI shows multiple echogenic foci with prominent posterior acoustic shadowing (arrows).



**A**



**B**



**C**



**D**

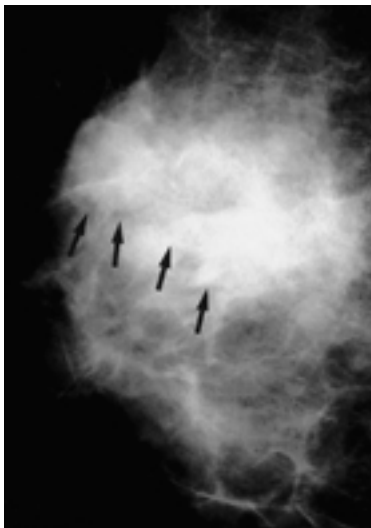
**Fig. 4.** Invasive ductal carcinoma in left breast in a 47-year-old woman.

**A.** Spot compression mediolateral oblique mammogram shows relatively ill-defined mass like density with clustered microcalcifications in left upper inner breast.

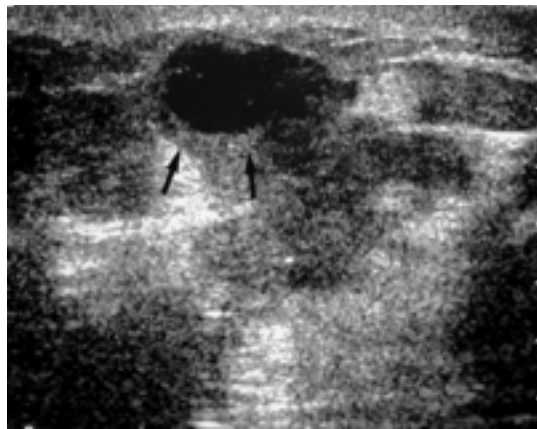
**B.** CUS shows multiple irregular shaped hypoechoic lesions (arrows) with involvement of focal dilated lactiferous duct (open arrow).

**C.** RCUS shows more distinctive margin of scattered lesions (arrows) with ductal involvement (white arrow).

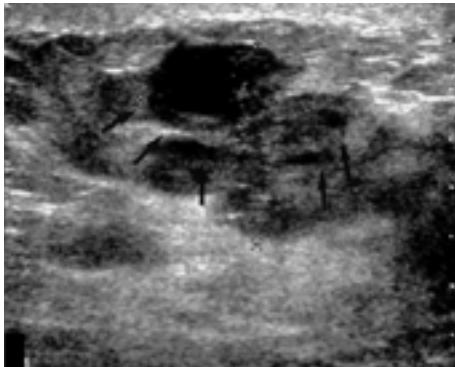
**D.** PIHI shows indistinct margin of the mass (arrows).



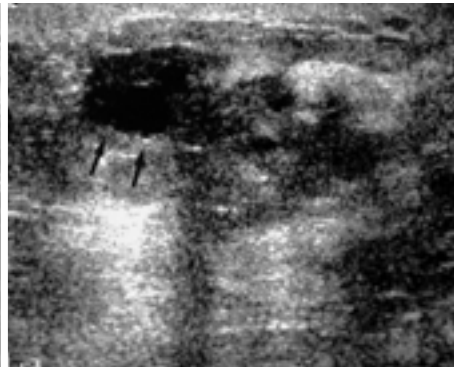
A



B



C



D

**Fig. 5.** Invasive ductal carcinoma in right breast in a 27-year-old woman.

**A.** Mediolateral oblique mammogram shows an ill defined high density lesion (arrows) in right upper medial breast.

**B.** CUS shows an ill-defined hypoechoic mass with internal necrosis (arrows).

**C.** RCUS shows a more distinct feature of multiple necrotic foci in mass (arrows).

**D.** PIHI shows more indistinctive margin of necrosis (arrows).

Notes CUS : Conventional ultrasonogram

RCUS : Real-time compound ultrasonogram

PIHI : Pulse inversion harmonic image

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1. Robert R. Entrekin, Bruce A. Porter, Henrik H. Sillesen, Anthony D. Wong, Peter L. Cooperberg, Cathy H. Fix. Real-time spatial compound imaging: Application to breast, vascular, and musculoskeletal ultrasound. *Semin Ultrasound CT MR* 2001;22:50-64
2. Terry S. Desser and R. Brooke Jeffrey. Tissue harmonic imaging techniques: Physical principles and clinical applications. *Semin Ultrasound CT MR* 2001;22:1-10
3. Cole-Beuglet C, Soriano R, Kurtz A, et al. Ultrasound analysis of

- 104 primary breast carcinomas classified according to histopathologic type. *Radiology* 1983;147:191-196
4. Egan R, Egan K. Automated water-path full-breast sonography: Correlation with histology of 176 solid lesions. *AJR Am J Roentgenol* 1984;143:499-507
5. Harper P, Kelly-Fry E. Ultrasound visualization of the breast in symptomatic patients. *Radiology* 1980;137:465-469
6. Gisbold JJ, Martin JK Jr. Prebiopsy localization of nonpalpable breast lesions. *AJR Am J Roentgenol* 1984;143:477-481
7. Rosenberg AL, Schwartz GF, Feig SA, Patchefsky AS. Clinically occult breast lesions: localization and significance. *Radiology* 1987;162:167-170
8. Bassett LW, Liu TH, Giuliano AI, Gold RH. The prevalence of carcinoma in palpable vs impalpable, mammographically detected lesions (comment). *AJR Am J Roentgenol* 1992;158:688-689
9. mammotome 2001; 44:545-551
10. 가 2000;19:335-341
11. Choi BI, Kim TK, Han JK, Kim AY, Seong CK, Park SJ. Vascularity of hepatocellular carcinoma: assessment with contrast-enhanced second-harmonic versus conventional power Doppler US. *Radiology* 2000;214:381-386
12. Lindner JR, Villanueva FS, Dent JM, et al. Assessment of resting perfusion with myocardial contrast echocardiography: theoretical and practical considerations. *Am Heart J* 2000;139:231-240
13. Seidel G, Greis C, Sonne J, et al. Harmonic greyscale imaging of the human brain. *J Neuroimaging* 1999;9:171-174
14. Hann LE, Bach AM, Cramer LD, et al. Hepatic sonography: comparison of tissue harmonic and standard sonography techniques. *AJR Am J Roentgenol* 1999;173:201-206
15. Sehgal CM, Arger PH, Pugh CR, et al. Comparison of power Doppler and B-scan sonography for renal imaging using a sonographic contrast agent. *J Ultrasound Med* 1998;17:751-756
16. Kim BH, Lim HK, Choi MH, et al. Detection of parenchymal abnormalities in acute pyelonephritis by pulse inversion harmonic imaging with or without microbubble ultrasonographic contrast agent: correlation with computed tomography. *J Ultrasound Med* 2001;20:5-14
17. Burns PN, Wilson SR, Simpson DH. Pulse inversion imaging of liver blood flow: improved method for characterizing focal masses with microbubble contrast. *Invest Radiol* 2000;35:58-71
18. Kim AY, Kim TK, Kim YH, Han JK, Choi BI. Comparison of harmonic and conventional power Doppler ultrasonography for assessment of slow flow in hyperechoic tissue: experimental study using a Doppler phantom. *Invest Radiol* 2000;35:105-110

## Value of Real-time Compound US in Diagnosis of Malignant Tumor in Breast Comparing with Conventional US, and Pulse Inversion Harmonic Images<sup>1</sup>

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**Purpose:** To compare the usefulness of real-time compound US (RCUS) with that of conventional US (CUS) and pulse inversion harmonic (PIH) imaging in the diagnosis of malignant breast tumors.

**Materials and Methods:** In 22 female patients whose mean age was 49 years, we evaluated the RCUS findings of pathologically proven [core biopsy ( $n=9$ ), mammotome tissue biopsy ( $n=10$ ), excisional biopsy ( $n=3$ )] malignant breast tumors, comparing them with the findings of CUS and PIH imaging. Evaluation of these masses was in terms of their marginal distinction, internal echogenicity, boundary and posterior echo pattern, relationship with the adjacent lactiferous ductal system, and the presence of necrosis (12/22) and calcification (6/22).

**Results:** In terms of marginal distinction, internal echogenicity, boundary echo patterns, and the relationship with adjacent ductal system, RCUS was superior to both conventional US and PIH Imaging ( $p < 0.05$ ).

**Conclusion:** For the diagnosis of malignant breast tumors RCUS was more useful than CUS or PIH imaging.

**Index words :** Breast neoplasms, diagnosis  
Breast neoplasms, US  
Breast, US

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