

ATS-539

가¹

. 2 . 3 . 4 . 5 . 6 . 7 . 8

: ATS-539

: 120 108 3.0 - 5.0 MHz
가
-
. ATS-539
8
가 , 가 ,
/ 가 Mann -
Whitney U test ROC 가
: , , 91.7%, 94.4%, 76.9%
가 , 108 78 가 (72.2%).
가 8 mm 62.4% 69.3%
가
: ATS-539 , ,
72.2% 8 mm
가 .

5 가 가 (1).
가
가
. 2003
ATS-539 (ATS Laboratories, Bridgeport,
CT, U.S.A.) (2).
2004 가 /
, CT, MR 가 ,
가가 .

1 ATS-539
2 8가 가
3
4
5
6
7
8

2006 4 1 2006 11 30
120
(ADC; Analogue Digital Converter,
Petamotion 2.0 ,) ATS-539
(3).

8가

/

5가

가

1) 2004 273 , 5,471

784 1
87 4,600 (84.1%)

2) 15

3)

가

4)

가 가

(software)

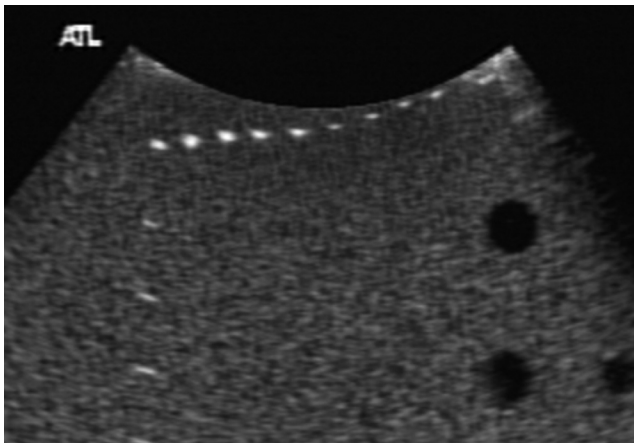


Fig. 1. Dead zone. Nine echoes are positioned 2-10 mm below the scan surface with 1 mm distance. All nine echoes are clearly visualized.

1)

2) 14 - 16 cm

3)

(2 - 5 MHz)

4) ATS-539

가

5)

6)

가

3

가

ATS-539

(4, 5)

ATS-539

8가

1) (Dead zone) (Fig. 1)

(fluctuation)

pulsing/receiving section

. 9

2 - 10 mm

5

가

9

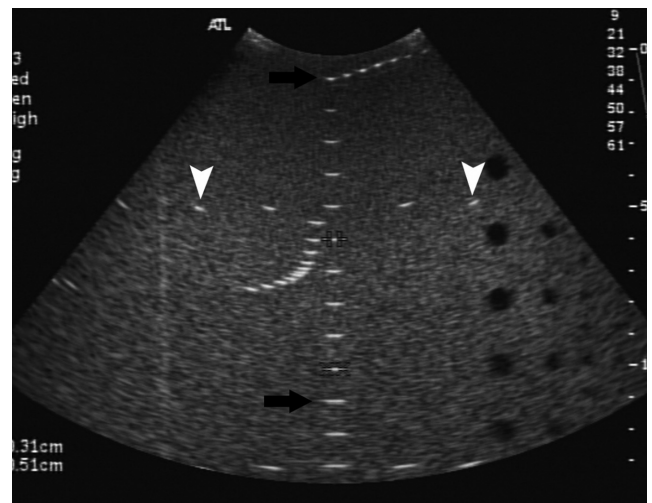


Fig. 2. Vertical and horizontal measurement. 10 cm distance at perpendicular line is measured from 1 cm to 11 cm (black arrows) below the scan surface for the vertical measurement, and 8 cm between horizontal targets (white arrows) are measured for the horizontal measurement.

가 9 가

2) (Vertical measurement) (Fig. 2)

17
1.0 ± 0.1 cm 가

1 - 11
cm 10 cm (, 10 ± 1 cm).
3) (Horizontal measurement)

2 cm 2 cm
± 1 mm . 8
cm (, 8 cm ± 4 mm).

4) / (Axial/lateral resolution) (Fig. 3)

1 mm 2.0 mm,
3.0 mm, 4.0 mm 가 가
5.0 mm .
11

5) (Focal zone)
(focal point)
가

6 - 7 cm
4 cm

$$(\%) = \frac{6-7 \text{ cm}}{4 \text{ cm}} \frac{(\text{in focus})}{(\text{out focus})} \times 100$$

6) (Sensitivity; , maximum depth penetration) (Fig. 4)

8 mm, 6 mm, 4 mm, 3 mm, 2 mm
6 mm 2 cm 1 cm
16 cm . 8 mm
8
가 16.0 ± 1.0 cm
8

mm 가
7) (Functional resolution definition and fill-in)

8 mm

180 °

8) (Gray scale and dynamic range) (Fig. 5)

, 가

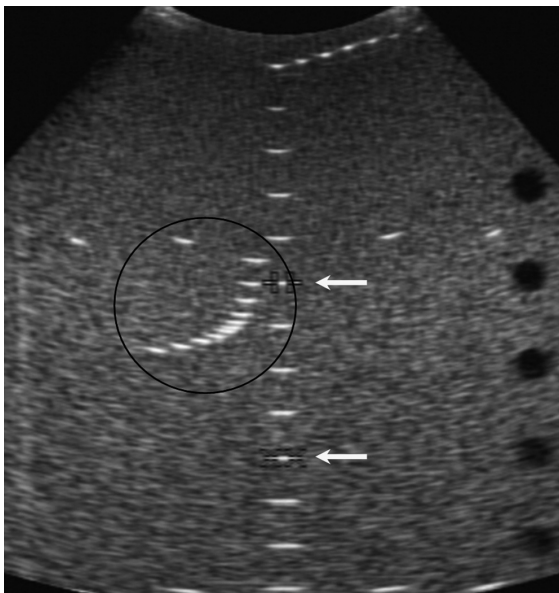


Fig. 3. Focal zone and axial/lateral resolution. Eleven targets with curved array must be visualized separately for acceptable axial/lateral resolution. Transverse length of targets located at 6 cm and 10 cm in depth are measured for the evaluation of focal zone.

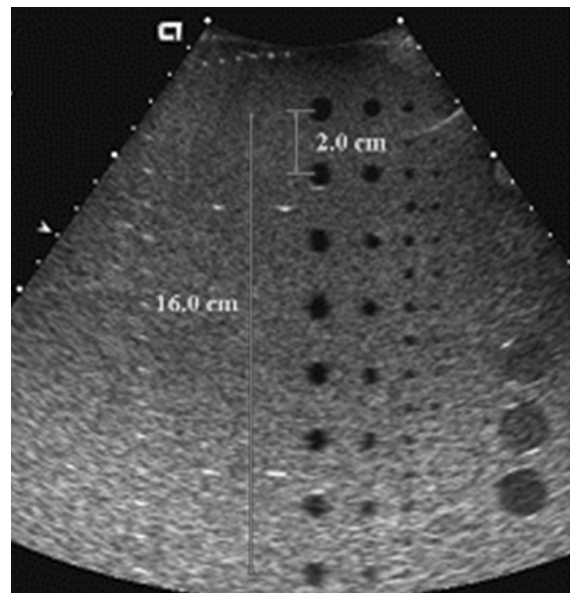


Fig. 4. Sensitivity and functional resolution. 8 mm sized cystic structures are well visualized on the most of ultrasound equipments. Cystic structures clearly demonstrated over 180 ° are counted.

6 8) 가
9) , , 가
180 °
8가 1) 2) 가 8
3) 4) / , 가
5) 5 11 가
92 - 94
Ultramark - 9 (Advanced Technology Laboratory, Bothell, U.S.A.) 64 channels 가
Ultramark - 9
5
1) 9 가
2) / 11
3) 6 4
180 °
가
1) PACS (Petavision 1.0, ,
,) server
7) 5M pixel (Wide, ,
)

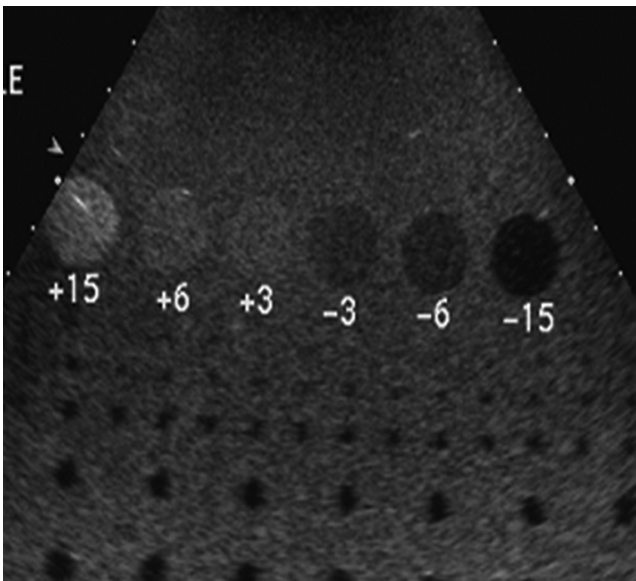
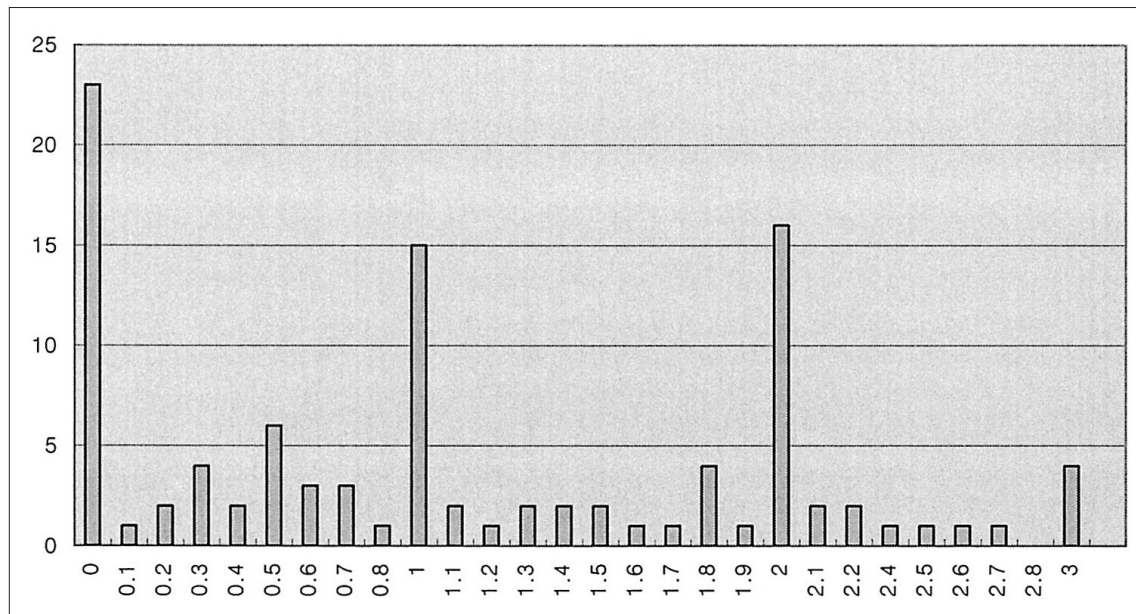


Fig. 5. Gray scale and dynamic range. Four or more targets must be clearly visualized over 180 °among six targets for acceptable gray scale and dynamic range.

1) 가 / 3
가 Mann - Whitney U test
2) (reference standard) ROC
가 /
784 273 , 5,471 1
87 4,600
(84.1%)
120
, 155
18
108 , 137 137

Table 1. Number of US Equipments on Detection of Dead Zone Targets

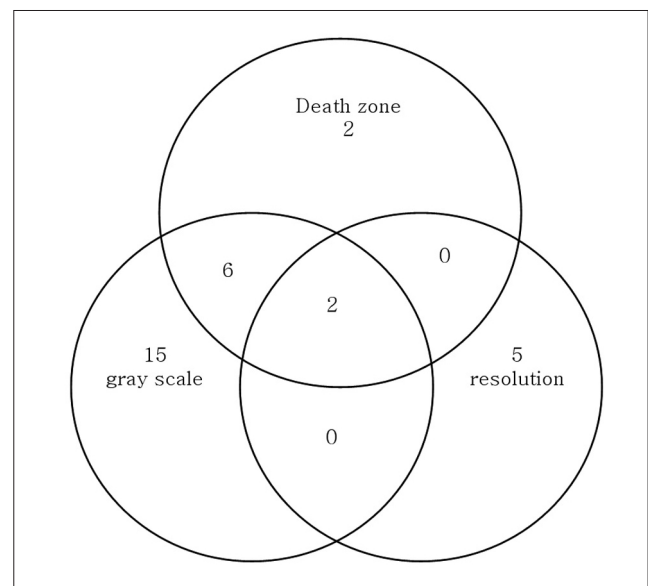
No. of dead zone targets	9	8	7	6	5	4	3	2	1	Total
No. of US equipments	99	4	2	1	0	1	0	0	1	108
(%)	91.7	3.7	1.9	0.9	0.0	0.9	0.0	0.0	0.9	100

Table 2. Number of US Equipments on Error in Vertical Measurement

3 가 8 , 20 1
. 18
15 ,
가 3 .
5,471 120 , 4,580 가
108 , 4,458
가 .

1)
91.7% 9 (Table 1).
2)
3
4
10% (Table 2).
3)

3
105 2 cm 1 4)
mm 가 8 cm 4 mm 가 11 /
29.6%가 . 6 mm (Table 4).
82.4%가 (Table 3). 5)
94.4%

**Fig. 6.** Causes of incongruence.

= 2 r	6 cm	10 cm	. 10 cm
6:10			8 mm, 6 mm, 4 mm, 2
60%	. 6 cm		mm, 1 mm
	60%		23.1%, 3.7%, 13.9%, 2.8%, 0.9%
36.1%	(Table 5).		(Table 6).
6)			8)
			4
			76.9%
			(Table 7).
	14 cm	8 mm	
7)			

Table 3. Number of US Equipments on Error in Horizontal Measurement

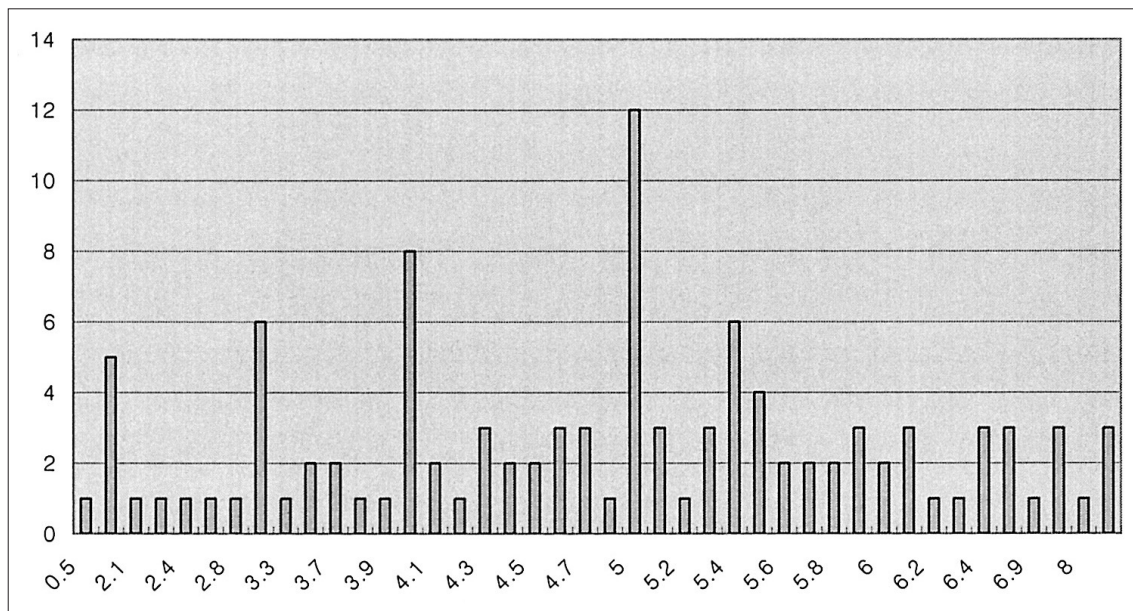


Table 4. Number of US Equipments on Lateral/Axial Resolution

No. of targets	11	10	9	8	7	6	5	4	3	Total
No. of US equipments	102	2	1	1	2	0	0	0	0	108
(%)	94.4	1.9	0.9	0.9	1.9	0	0	0	0	100

Table 5. Number of US Equipments on Focal Zone Rate

Focusing rate (%)	- 40	41 - 50	51 - 60	61 - 70	71 - 80	81 - 90	91 - 100	Total
No. of US equipments	2	10	27	31	27	6	2	105
(%)	1.9	9.3	25.0	28.7	25.0	5.6	1.9	100

Table 6. Number of US Equipments on Functional Resolutions Classified by Size and Depth

size	order	8th	7th	6th	5th	4th	3rd	2nd	1st
8 mm		4	2	19	22	33	13	14	1
6 mm				4	7	24	36	29	8
4 mm		4	4	7	14	16	27	20	16
3 mm				3	4	15	26	24	36
2 mm				1	0	1	4	17	85

Table 7. Number of US Equipments on Gray Scales

No. of gray scale	6	5	4	3	2	1	0	Total
No. of US equipments	5	18	60	22	3	0	0	108
(%)	4.6	16.7	55.6	20.4	2.8	0	0	100

Table 8. *p*-value in Mann-Whitney U Test about Measuring Items of US Phantom

	Vertical	Horizontal	Focal zone rate	Functional resolution 8 mm	Functional resolution 6 mm	Functional resolution 4 mm	Functional resolution 2 mm	Functional resolution 1 mm
Asymp.Sig (2-tailed)	0.139	0.333	0.044	0.001	0.277	0.098	0.135	0.277

Table 9. Congruence Rate of Items in US Phantom

	Vertical measurement	Horizontal measurement	Focal zone rate	functional resolution 8 mm	functional resolution 6 mm	functional resolution 4 mm	functional resolution 2 mm	functional resolution 1 mm
AUC*	0.588	0.559	0.624	0.693	0.565	0.601	0.590	0.546

AUC* = area under the ROC curve.

108 78 72.2% . / 62.4%, 69.3%
/ 가 (Table 9).

108 1 41
가 12 ,
30 , / 11 가 가
. 41 20
10 가 1
2 가 가 .
30 가
10 ,
23 , / 7 (6). , ,
가 가 가 (Fig. 6). 가 가 가
30 7 10 . 가 ,
10 13 10 .
. 10 13 5 가 (7, 8).
가 (hard copy) 가
5가 가
가 Mann - Whitney U test
reference standard ROC analysis
/ 가 . Mann - Whitney U test 8 mm (video capture card)
가 (3).
가 (Table 8). ROC , , (in Petamotion
focus/out focus), 8 mm , 6 mm .
, 4 mm , 2 mm , 1 mm
58.8%, 55.9%, 62.4%, 69.3%, 56.5%,
60.1%, 59.0%, 54.6% . 8 mm ,

9

가

(6).

가

가

가

가

가

가

(9)

ATS-539

7가

가

가

가

가

5

가

가

가

/

가 2004

가

가

3

가 23.1%

가

17가

가

17

30

27.8%

10

가

가

. 273 , 5,471 87 ,

4,600 (84.1%)가

108

5,710

23

659 가

108

가

가

30

860 가

가

2004

190

10

가

1

41

20

가

21

1. . 235 .

: 2003

2. , , , , , in

34

. 2003

3. Gibson NM, Dudley NJ, Griffith K. A computerised quality control testing system for B-mode ultrasound. *Ultrasound Med Biol* 2001; 27:1697-17114. ATS Laboratories. *Test performed*. Bridgeport, CT: ATS Laboratories, Inc., 20005. ATS Laboratories. *Clinical quality assurance phantoms: Multipurpose phantom model 539*. Bridgeport, CT: ATS Laboratories, Inc., 20006. Alasaarela E, Koivukangas J. Evaluation of image quality of ultrasound scanners in medical diagnostics. *J Ultrasound Med* 1990; 9:23-347. Meuwly JY. Quality control in ultrasonography. *Ther Umsch* 1997; 54:37-43

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5,710 가

659

4

가

4 가

4

3,440

15.1%

Quality Assessment of Ultrasonographic Equipment Using an ATS-539 Multipurpose Phantom¹

Pyo Nyun Kim, M.D., Joo Won Lim, M.D.², Hyun Cheol Kim, M.D.³, Young Cheol Yoon, M.D.⁴,
Deuk Je Sung, M.D.⁵, Min Hoan Moon, M.D.⁶, Jeong Sook Kim, M.D.⁷, Jong Chan Kim, M.D.⁸

¹Department of Radiology and Research Institute of Radiology, University of Ulsan College of Medicine

²Department of Radiology, Kyung Hee University Hospital, College of Medicine, Kyung Hee University

³Department of Radiology, East-west Neo Medical Center, College of Medicine, Kyung Hee University

⁴Department of Radiology, Sam Sung Seoul Hospital, Sung Kyunkwan University

⁵Department of Radiology, College of Medicine, Korea University

⁶Department of Radiology, College of Medicine, Kwandong University

⁷Department of Radiology, Dongguk University International Hospital

⁸Korea Industry & Technology Research Institute

Purpose: To determine the rate of congruence and to standardize assessment of US (ultrasound) phantom images with the use of an ATS-539 multipurpose phantom for US equipment currently utilized in Korea

Materials and Methods: US phantom images were scanned with a 3.0 - 5.0 MHz convex transducer and were digitized by use of an analogue-digital converter. Members of a committee with consent evaluated the US phantom images from 108 types of ultrasound equipment. The dead zone, vertical and horizontal measurement, axial/lateral resolution, focal zone, sensitivity, functional resolution and gray scale/dynamic range were evaluated. Congruence or incongruence of ultrasound equipment was determined based on the results of dead zone, axial/lateral resolution and gray scale/dynamic range measurements. Other factors were evaluated for the possibility as criteria with the use of the Mann-Whitney U test and receiver operator characteristic (ROC) curve analysis.

Results: The dead zone, axial/lateral resolution and gray scale/dynamic range were 91.7%, 94.4% and 76.9%, respectively, for suitable US equipment. Considering all three factors, 78 types of ultrasound equipment were passed. The congruence rate of focal zone and functional resolution were 62.4% and 69.3% of the US equipment, respectively.

Conclusion: Of the US equipment, 72.2% of the equipment was acceptable based on the dead zone, axial/lateral resolution, and gray scale/dynamic range measurements as determined with the use of an ATS-539 phantom. Focal zone and 8 mm-functional resolution can be useful as a standard in the assessment of a US phantom image.

Index words : Ultrasonography
Equipment
Phantom
Quality control
Quality assessment

Address reprint requests to : Pyo Nyun Kim, M.D., Department of Radiology and Research Institute of Radiology, University of Ulsan
College of Medicine, 388-1, Poongnap-dong, Songpa-gu, Seoul 138-736, Korea.
Tel. 82-2-3010-4376 Fax. 82-2-476-0090 E-mail: pnkim@amc.seoul.kr