

CT

:

1

. . . 2 .

: CT (mean density)가

: (2 - 9 cm)가 45 CT HiSpeed Advantage
(GE medical system) CT , 가
(soft), (standard), (detail) (bone)
50, 200, 350 mm²
. 21

: 1 HU 0.1 -
1.9 (350 mm²), 0 - 4.2 (200 mm²), 0.1 - 3.6 HU (50 mm²)
0.5 - 1.2 HU , 350 mm²
0 - 1.6 HU . 4
가 (p = 1.000).
: 2 cm CT 가 가 .

CT (Hounsfield Unit; HU) CT
X- 가 가
(1). CT 가 (13 - 15).
, (region of interest)
가 (2 - 8). (mean density)가
CT 가 가
, 가 . CT
, kVp, mA, CT
(reconstruction algorithm) (16), CT
(9, 10). 가
(bone algorithm),
(standard algorithm) ,
(11, 12). 1980 CT 가
CT
CT

1

2

가 45 29 78
 (62) 가 32 , 가 13
 45 31 (27
 , 4), 1 , 1
 3 ,
 가 9 2 - 9 cm
 4.3 cm
 CT HiSpeed Advantage (GE medical system, Milwaukee, WI) 120 kVp, 150 mA, pitch 1:1
 3 - 10 mm
 (Iomeron 300, Bracco S.p.A, Milano, Italy) 70 cc
 50 cc 120 cc 3 mL/sec
 25 10 mm 50
 (field of view; FOV) 34 cm (matrix) 512 × 512 (window level) (window width) 10 HU 350 HU, - 700 HU 1500 HU
 (soft), (standard), (detail) (bone) 4가 (Fig. 1), 가 CT

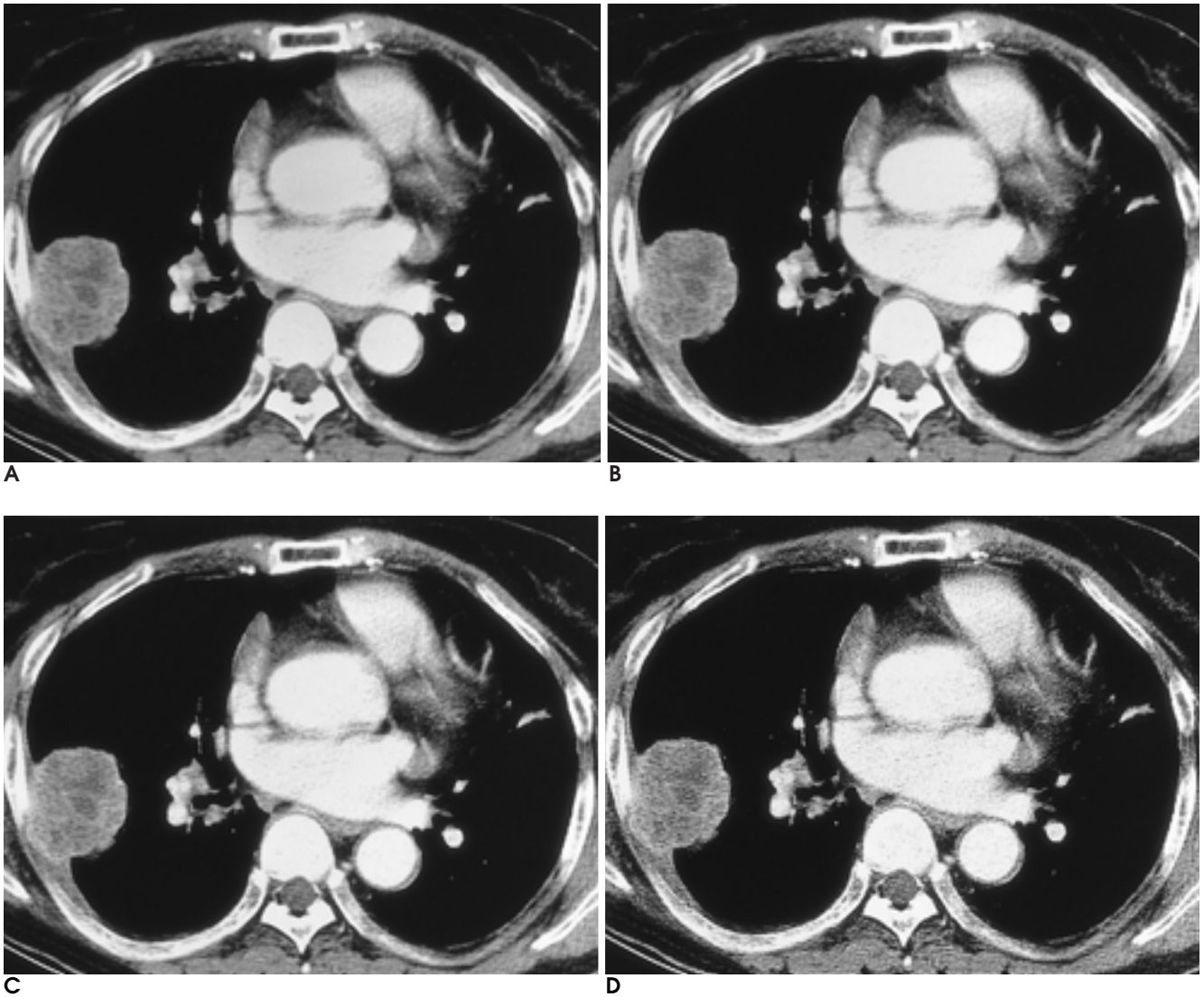


Fig. 1. Examples of CT images reconstructed with 4 different algorithms in a 62 year-old woman with lung cancer in right lower lobe. Reconstruction algorithms are used soft (A), standard (B), detail (C), and bone (D) algorithms.

(region of interest, ROI)
 50 mm², 200 mm², 350 mm² 3가
 가 가
 (Fig. 2). 2 cm 1 350 mm²
 가 CT
 , , , 200 mm²
 가
 (fissure) (erector spinae) (supraspinatus), (infraspinae)
 ,
 21 4가

Table 1. Mean Density and Its Maximum Difference (Mean \pm Standard Deviation in Hounsfield Unit) of Lung Mass in Images of 4 Different Reconstruction Algorithms (n = 45)

	ROI (mm ²)		
	50	200	350 or more*
Algorithms			
Soft	37.7 \pm 22.7	35.7 \pm 24.0	33.7 \pm 27.4
Standard	37.8 \pm 22.6	35.8 \pm 24.0	33.8 \pm 27.4
Detail	37.9 \pm 22.5	35.8 \pm 23.9	33.8 \pm 27.3
Bone	38.0 \pm 22.7	36.0 \pm 24.0	34.0 \pm 27.2
Maximum difference (range)	0.8 \pm 0.7 (0.1 - 3.6)	0.7 \pm 0.7 (0.0 - 4.2)	0.6 \pm 0.4 (0.1 - 1.9)

Note- ROI: region of interest

*n = 44

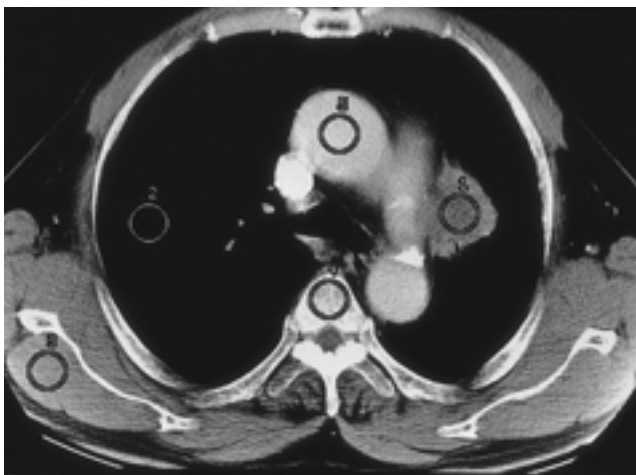


Fig. 2. Axial CT image through carina in 47 year-old man with lung cancer in left upper lobe.

Region of interest are located within lung mass, normal lung, muscle, bone and vessel for the measurement of mean value and standard deviation (SD) of CT densities.

(
)
 .
 4 4가 가
 SPSS for Windows
 (one - way ANOVA)
 .

4 45 Table 1
 가 ,
 가
 가 (p = 1.000),
 1 HU . 50 mm² 200
 mm²
 가 350 mm²
 350 mm² 0.1 - 1.9 HU
 . 200 mm²
 2 HU 가 1
 0 - 4.2 HU 가
 200 mm² 2
 HU . 50 mm²
 가 0.1 - 3.6 HU
 (Fig. 3).

(p = 1.000)(Table 2).

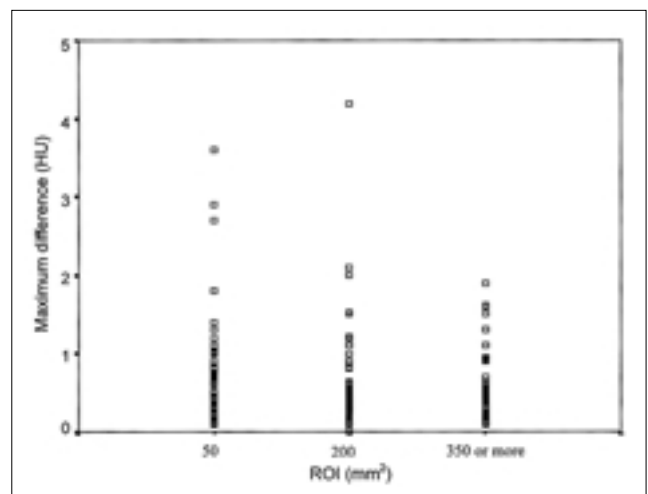


Fig. 3. Distribution of maximum difference of mass density measured at images of 4 different reconstruction algorithms in 45 patients.

Maximum difference are mostly less than 2 HU. Number of larger difference increases with small regions of interest (ROI)

Table 2. Degree of Enhancement at Delayed Phase and Its Maximum Difference (Mean \pm Standard Deviation in Hounsfield Unit) of Lung Mass in Images of 4 Different Reconstructed Algorithms (n=21)

	ROI (mm ²)		
	50	200	350 or more*
Algorithms			
Soft	19.0 \pm 19.2	20.1 \pm 19.9	22.6 \pm 20.0
Standard	19.3 \pm 19.3	20.2 \pm 19.9	22.6 \pm 20.0
Detail	19.4 \pm 19.3	20.2 \pm 19.9	22.5 \pm 20.0
Bone	19.5 \pm 19.7	20.3 \pm 19.6	22.4 \pm 20.0
Mixed [†]	18.9 \pm 18.9	19.4 \pm 20.6	21.5 \pm 21.1
Maximum difference (range)	1.2 \pm 0.9 (0.1 - 3.4)	0.9 \pm 0.8 (0.1 - 3.4)	0.5 \pm 0.4 (0.0 - 1.6)

Note- ROI: region of interest

*n = 20

[†]Unenhanced scans with bone algorithm and delayed enhanced scans with standard algorithm were used

Table 3. Mean Density and Its Maximum Difference (Mean \pm Standard Deviation in Hounsfield Unit) of Normal Thoracic Tissues in Images of 4 Different Reconstruction Algorithms (n = 45)

	Lung	Muscle	Bone	Vessel
Algorithms				
Soft	- 798.2 \pm 56.1	40.3 \pm 14.9	160.0 \pm 41.5	171.5 \pm 40.2
Standard	- 798.4 \pm 56.1	40.3 \pm 14.9	160.0 \pm 41.5	171.5 \pm 40.2
Detail	- 798.6 \pm 56.2	40.3 \pm 14.9	159.8 \pm 41.6	171.5 \pm 40.4
Bone	- 797.2 \pm 56.3	40.6 \pm 14.8	160.6 \pm 41.3	171.4 \pm 40.3
Maximum difference (range)	1.5 \pm 0.6 (0.4 - 3.6)	0.6 \pm 0.4 (0.0 - 2.1)	1.3 \pm 0.9 (0.1 - 4.0)	0.5 \pm 0.7 (0.0 - 4.1)

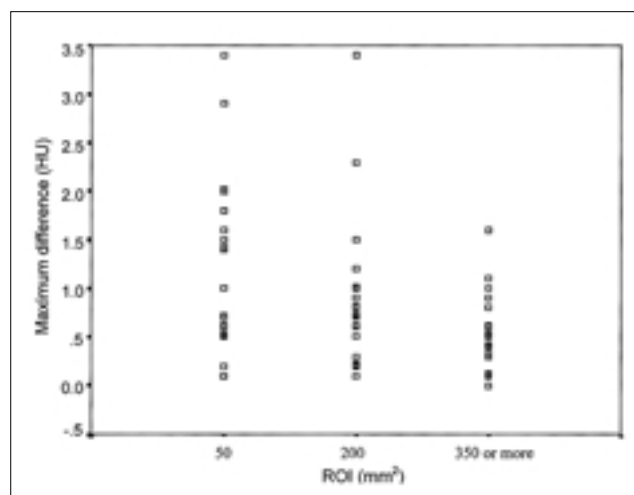


Fig. 4. Distribution of maximum difference of enhancement degree of lung mass measured at images of 4 different reconstruction algorithms in 21 patients.

With ROI of 350 mm² or more, maximum difference are all 1.6 HU or less. Number of larger difference increases with small region of interest (ROI).

Table 4. Standard Deviations of CT Numbers (HU) in ROI (Mean \pm Standard Deviation in Hounsfield Unit) According to Different Reconstruction Algorithms (n = 45)

Algorithm	Mass	Lung	Muscle	Bone	Vessel
Soft	15.9 \pm 13.3	33.5 \pm 17.0	15.9 \pm 9.4	35.7 \pm 14.5	9.5 \pm 4.9
Standard	16.8 \pm 13.4	34.8 \pm 17.0	17.1 \pm 9.3	38.3 \pm 14.9	10.6 \pm 4.8
Detail	19.2 \pm 24.6	37.4 \pm 33.5	18.6 \pm 9.2	40.2 \pm 15.0	11.8 \pm 4.7
Bone	25.7 \pm 11.9	44.7 \pm 40.9	28.2 \pm 9.0	54.2 \pm 17.1	20.7 \pm 6.5

350 mm²
0 - 1.6 HU
가
4
Table 3
가
(= 1.000).
가
4.1 HU
(Table 3).
15.9 HU,
19.2 HU,
가
8.9 HU
(Table 4).

(detector)
CT
(filtered back projection)
(sine & cosine)
(spatial frequency filtration process)
(image plane)
1980
CT
(2, 3),
CT 가 CT , kVp, mA,
,
CT
(17, 18). Zerhouni
(phan -
CT 가
(19).
CT

가 .

가 가 CT 가

가 . CT

가 9% 가

(smooth algorithm)

(20).

가

(sharpness) (smoothness)

GE CT

(soft), (standard), (detail) (bone)

, Siemens (soft), (standard),

(high - resolution), (ultra high - resolution)

CT 가

(13 - 15).

Swensen (4)

40 HU 12 HU

20 HU

, Yamashita (5)

20 - 60 HU

CT CT

CT

1 HU 350 mm²

가 2 HU

가 가

가 ,

CT

가

(partial volume averaging effect)

가

overshoot - undershoot effect

CT ,

CT

가

CT 가

(16). Groell CT

CT (electron - beam CT) CT

가 , , ,

CT 가 (21).

Somatom Plus Scanner (Siemens, Erlangen, Germany)

(polyethylene foam)

Kemerink , ,

25 cm²

0.1 HU

가 +2.0 HU (22).

(water phantom) 4가

가 0.3 HU

CT

15.9, 16.8, 19.2,

25.7

CT

(periodic noise)

overshoot - undershoot

(signal -

to - noise ratio) (18).

가 CT

, 50 mm²(7 mm) 200 mm²

(14 mm) 2 HU

가

가

가 2 cm

200 mm² 가

가 overshoot - undershoot

가

가

CT , CT

가 , 2 cm CT

가 가

가 가

가 CT

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CT Densitometry of Lung Mass: The Effect of Reconstruction Algorithm¹

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Purpose: To evaluate the effect of reconstruction algorithms on the CT measurement of mean lung mass density and normal thoracic structures.

Materials and Methods: Forty-six patients with a 2 - 9 cm-sized lung mass underwent thoracic CT examinations with intravenous contrast enhancement and using a CT HiSpeed Advantage scanner (GE Medical Systems). In each examination, the axial image of the lung mass was reconstructed using soft, standard, detail, and bone algorithms. The mean value and standard deviation of mass density in Hounsfield Units (HU) were measured using ROIs of three different sizes (50 mm², 200 mm², and 350 mm² or more), and the same method was used to measure the density of normal lung, muscle, bone, and vessels. In 21 patients, mass density was also measured on unenhanced and delayed enhanced images and the degree of enhancement was calculated.

Results: The average maximum difference in mean mass density in the images of the four different algorithms was less than 1 (range, 0.1 - 1.9) HU (ROI size, 350 mm² or more), 0 - 4.2 HU (200 mm²), and 0.1 - 3.6 HU (50 mm²). The average maximum difference in the degree of lung mass enhancement was 0.5 - 1.2 (range, 0 - 1.6) HU (ROI size, 350 mm² or more). The mean density of the four normal thoracic structures was highest in images reconstructed with the bone algorithm, though there was no significant difference between the four different algorithms ($p = 1.000$).

Conclusion: The measured mean CT density of a lung mass larger than 2 cm does not significantly change according to the reconstruction algorithm used. When using a small ROI, however, the density difference may increase.

Index words : Computed tomography (CT), image processing
Lung, CT
Lung, density
Lung neoplasms, CT

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1) 4.0 4.0

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