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1

2

3

: CT (bolus - tracking technique)
(fixed scan delay protocol)
: 16 MDCT CT 526
(1 2) (3 4) 300 mgI/mL (1 3)
370 mgI/mL (2 4) 2 mL/kg, 3 mL/sec
100 HU 20 , 38
: 1 2 38±3.8 , 37.4±3.4
1 2 3 4 (115.5±15.4 vs
111.7±15.1 HU; $p=0.093$, 128.3±17.1 vs 119±17.1HU; $p=0.003$)

: CT

가 (multi - 35 - 50 , 50 - 70
phase) (computed tomography, CT) 가 (3, 6 - 8). 1
(1 - 6). CT 4 MDCT 16
CT (multidetector - row spiral computed tomography, MDCT) (bolus - tracking
MDCT technique) (fixed scan delay protocol)
CT CT
(pancreatic phase) (time - density curve)
가 (liver) CT
(3, 6). 16 (9 - 11). CT
MDCT MDCT
14 - 20
(scan time -
delay, scan time window) CT

1
2
3

2006 11 20

2007 1 23

100 HU

100HU (region of interest, CT (attenuation value))

2005 2 3 CT ROI) CT (attenuation value)

4

(carcinomatosis)

www.rad.jhmi.edu/jeng/javarad/samplesize/ (appropriate sample size)

CT (minimum expected difference) 10 (estimated standard deviation) 20 p 0.05 (statistical power) 0.80

1). 가 (417), (23), 125 Kruskal - Wallis test, one way ANOVA (Analysis of variance) (Pearson's correlation coefficients)

16 MDCT (Somatom Sensation 16; Siemens, Erlangen, Germany) 120 kV, 300 mAs 100 H 0.5 , 18 mm, (collimation) 1.5 mm 3 mm, (increment) 3 mm

ANOVA CT ANOVA

1 3 iodine 300 mg/mL (Omnipaque 300; Nycomed Amersham, Oslo, Norway) 2 4 370 mg/mL (iopamiro; Bracco, Milano, Italy) p 0.05 (EnVision CT; Medrad, Pittsburgh, Pa, U.S.A.)

3 mL/sec 1 kg 2 mL/kg 60 kg 120 mL, 75 kg 226 , 84 , 161 , 55 가 150 mL (1 2) (Table 1). 1 2 100 HU 18.1±3.8 , 17.4±3.4 38.0±3.8 , 37.4±3.4 HU (Hounsfield Unit) 20 , 74.0±5.3 , 74.4±3.5 38 3 4 38 24 (74.3±3.5 , 74.6±3.4

Table 1. Group Characteristics

	CT Protocol	Number	Sex (M:F)*	Age [†]	Body weight (kg) [‡]	Contrast Material(ml) [§]
Group 1	Bolus-tracking, 300 mg/cc I	226	143:83	55.4 ± 13.7 (19 - 90)	62.2 ± 9.6 (40 - 97)	128.8 ± 10.8 (120 - 150)
Group 2	Bolus-tracking, 370 mg/cc I	84	52:32	55.1 ± 12.0 (17 - 78)	62.2 ± 10.2 (40 - 92)	129.4 ± 11.3 (120 - 150)
Group 3	Fixed scan delay, 300 mg/cc I	161	100:61	54.7 ± 12.8 (17 - 79)	62.2 ± 10.2 (37 - 97)	129.7 ± 11.7 (120 - 150)
Group 4	Fixed scan delay, 370 mg/cc I	55	41:14	56.9 ± 12.2 (16 - 82)	63.1 ± 9.8 (45 - 86)	129.7 ± 11.7 (120 - 150)
Total		526	336:190	55.3 ± 12.9 (16 - 90)	62.3 ± 9.9 (37 - 97)	129.2 ± 11.2 (120 - 150)

* $p=0.376$

† $p=0.758$

‡ $p=0.94$

§ $p=0.863$

($p=0.178$, $p=0.707$) (Table 2).

100 HU

($r=0.18$, $p=0.001$;

$r=0.21$, $p < 0.001$) (Fig. 1, 2).

CT

가

(Table 3).

CT

($p < 0.001$) (Table

Table 2. Time to 100HU (TT100) and Scan Time-delay

	TT100*	Pancreatic Phase	Portal Venous Phase†
Group 1	18.0 ± 3.8 (10 - 30)	38.0 ± 3.8 (30 - 50)	74 ± 5.3 (53 - 85)
Group 2	17.4 ± 3.4 (9 - 27)	37.4 ± 3.4 (29 - 47)	74.4 ± 3.5 (66 - 85)
Group 3	18	38	74.3 ± 3.5 (57 - 81)
Group 4	18	38	74.6 ± 3.4 (58 - 77)

unit: second

* $p=0.178$

† $p=0.707$

4, Fig. 3).

CT

CT

1

3

2

4

(115.5 HU

vs 111.7 HU; $p=0.093$, 128.3 HU vs 119 HU; $p=0.003$) (Table 4, Fig. 3).

1

3

, 2

4

CT

(104.4 HU vs 104.8 HU; $p=1$, 112.1 HU vs 112.1 HU; $p=1$).

2

4

1

3

가

7.3 HU

12.8 HU

(

$p < 0.05$)

(Table 5, Fig. 3).

Table 3. CT Attenuation Values of 3 Parts of the Pancreas

	Head	Body	Tail
Pancreatic phase	116.8 ± 17.3	117.6 ± 16.5	115.8 ± 16.1
Portal venous phase	106.8 ± 13.2	107.4 ± 13.1*	105.4 ± 12.6*

nite HU, Hounsfield Unit

$p=0.038$

Table 4. Comparison of CT Attenuation between Groups with Different Techniques

	Group 1	Group 3	Attenuation Difference	p value
Pancreatic phase	115.5 ± 15.4	111.7 ± 15.1	3.78	0.093
Portal venous phase	104.4 ± 12.5	104.8 ± 12	- 0.41	1.0
	Group 2	Group 4	Attenuation Difference	p value
Pancreatic phase	128.3 ± 17.1	119.0 ± 17.1	9.25	0.003
Portal venous phase	112.1 ± 13.8	112.1 ± 12.9	- 0.04	1.0

unit HU, Hounsfield Unit

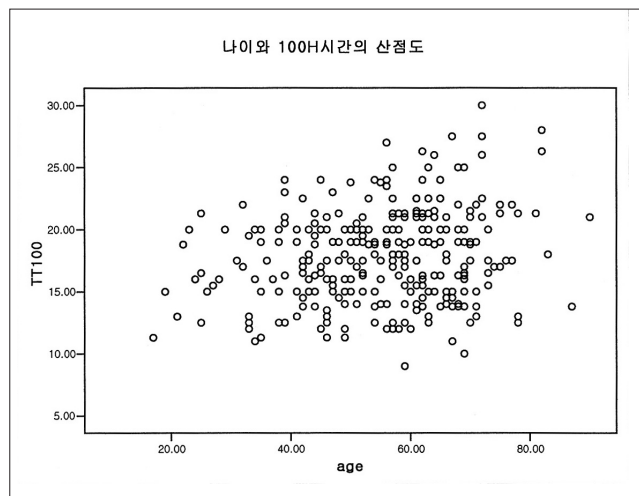


Fig. 1. Scatter diagram of TT100 and patients' age
There is a weak positive correlation between TT100 and patients' age in the group of bolus-tracking technique ($r=0.18$, $p=0.001$).

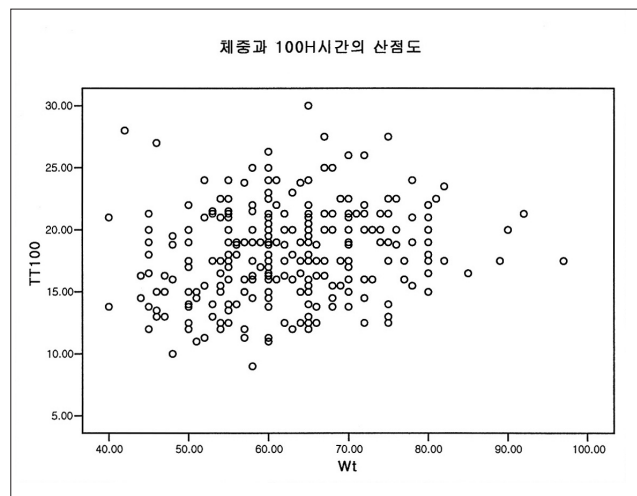


Fig. 2. Scatter diagram of TT100 and patients' body weight.
There is a weak positive correlation between TT100 and patients' body weight in the group of bolus-tracking technique ($r=0.21$, $p<0.001$).

Table 5. Comparison of CT Attenuation between Groups with Different Contrast Concentrations

	Group 1	Group 3	Attenuation Difference	p value
Pancreatic phase	115.5 ± 15.4	128.3 ± 17.1	- 12.81	<0.001
Portal venous phase	104.4 ± 12.5	112.1 ± 13.8	- 7.70	<0.001
	Group 2	Group 4	Attenuation difference	p value
Pancreatic phase	111.7 ± 15.1	119.0 ± 17.1	- 7.34	0.012
Portal venous phase	104.8 ± 12	112.1 ± 12.9	- 7.33	<0.001

unit HU, Hounsfield Unit

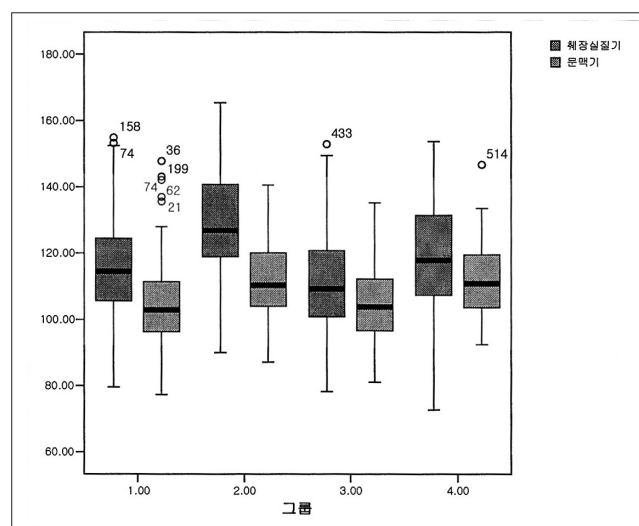


Fig. 3. Pancreatic CT attenuation values according to phases and groups.

In comparison of CT attenuation value between techniques, there was only significant difference between group 2 and 4. CT attenuation value of group 2 was slightly higher than that of group 4 ($p=0.003$). In comparison of CT attenuation value between contrast concentrations, high concentration groups showed higher attenuation values than low concentration groups in two phases ($p<0.05$). CT attenuation values of pancreatic phase were higher than those of portal venous phase in all groups ($p<0.001$).

가

CT

(protocol) . CT

CT

Yasuyuki (12) CT 2.0 - 2.5 mL/kg

(3, 6, 8).

가

CT

contrast enhancement time)

가

contrast enhancement)가

(13 - 17).

3 mL/sec 300 mg I/mL 370

mg I/mL 가

가

(Table 5). Fenchel (17)

CT CT

16 64 MDCT

McNulty (18) 4 MDCT 150 mL

4 mL/sec 35 , 60

mL/sec . Kim (14) 3

34 - 36

(hepatocellular

carcinoma) 16 MDCT

CT 100 HU

18 , 16 - 30

20 가

(,).

100 HU 20

38 1

2 100 HU 18.1 ± 3.8 , 17.4 ± 3.4

3 4 9 - 30

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Variation of Attenuation Value of Pancreas at Dual Phase MDCT: Comparison of the Bolus-tracking Technique vs. the Fixed Scan Delay Protocol¹

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Purpose: To clarify the difference between the bolus-tracking technique and a fixed scan delay protocol in the achievement of the optimal pancreatic phase of the pancreas with MDCT.

Materials and Methods: 526 patients underwent pancreatic and portal venous phase imaging of the pancreas using 16-channel MDCT. All the examinations were randomized into either scanning using a bolus-tracking technique with a scan delay of 20s after the aorta was enhanced > 100 HU (groups 1 and 2) or scanning with a scan delay of 38 s from the beginning of the injection (groups 3 and 4). A contrast material of 300 mgI/mL (groups 1 and 3) or 370 mgI/mL (groups 2 and 4) at an injection speed of 3 mL/sec was injected at 2 mL/kg body weight. The pancreatic CT attenuation values were compared.

Results: The scan delay times of the pancreatic phase in groups 1 and 2 were 38 ± 3.8 s and 37.4 ± 3.4 s, respectively. At the pancreatic phase, the pancreatic attenuation values of groups 1 and 2 were slightly higher than those of groups 3 and 4 (115.5 ± 15.4 vs 111.7 ± 15.1 HU; $p=0.093$, 128.3 ± 17.1 vs 119 ± 17.1 HU; $p=0.003$). There was no significant difference between groups at the portal venous phase.

Conclusion: The use of a bolus-tracking technique in the optimal pancreatic phase of pancreatic CT does not significantly improve the pancreatic enhancement but does at higher iodine concentrations.

Index words : Pancreas

Computed tomography (CT), helical

Computed tomography (CT), contrast media

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