

CT

1

2

CT (Hounsfield unit (HU) 1 mm² whirlpool, 가, , : 69% 94% HU 94% 가 . 9 (69%) 10 (56%), 가 5 (38%), 4 (22%), 3 (17%)가 , 4 (31%) 5 (28%)가 . : CT HU

가

가 (1, 2). , , ,

가

가 (6, 7, 16).

가 (7, 16)

37% (3, 4).

CT

(1, 5 - 10).

CT

(16, 17).

가

CT

Hounsfield Unit (HU)

HU

가

2004 8 23

2004 10 29

가 (,) ,
가 ,)
1996 5 2001 9
가 31
CT
13
14
(n=3)
가
(n=1)가 2 88 (53) , 20 11
CT GE HiSpeed Advantage (GE medical systems, Milwaukee, WI, U.S.A.) 120 ml
(Iohexol 300 mg/ml, Omnipaque™, NYCOMED, Cork, Ireland) (MCTPlus, Medrad, Pittsburgh, PA, U.S.A.) 3 ml/sec 5 - 7 mm
1.4:1 pitch, 7 mm
CT
30 70 - 80
CT
(4.5)
1 mm² (region of interest, ROI)
HU
HU 3
(subtraction)
(whirlpool)
가, 3 mm (17).
HU
Student t - test
CT 가 Fisher
exact test
56.5 ± 22.6
12.4 ± 11.4
가 (p<0.001) (Table 1, 2) (Fig. 1).

69%
HU 가 25HU
100% (Table 1, 3).
94% 가
CT
(n=13)가 가
(n=9), 가(n=5),

Table 1. Distribution of HU of Bowel Wall between Strangulated and Non-strangulated Small Bowel Obstruction

	Number of patients	HU of Well Enhanced Bowel (A)	HU of Poorly Enhanced Bowel (B)	A - B
Patients of strangulation	1*	93.3	10.0	83.3
	2*	88.7	46.7	42
	3	83.0	47.5	35.5
	4*	120.0	58.0	62
	5*	104.7	37.7	67
	6	82.0	53.7	28.3
	7*	89.3	48.0	41.3
	8	93.0	48.7	44.3
	9*	98.7	10.4	88.3
	10*	118.3	24.8	93.5
	11*	121.3	49.4	71.9
	12	95.3	47.3	48
	13*	105.0	76.0	29
Patients of non-strangulation	1	100.3	108.0	- 7.7
	2	106.0	98.3	7.7
	3	102.0	100.7	1.3
	4	76.3	81.3	- 5.0
	5	85.3	64.3	21.0
	6	73.0	77.3	- 4.3
	7	87.7	90.7	- 3.0
	8	86.0	84.7	1.3
	9	100.7	94.0	6.7
	10	117.3	106.3	11.0
	11	113.0	97.3	15.7
	12	94.0	80.7	13.3
	13	73.3	93.0	- 19.7
	14	117.0	100.3	16.7
	15	88.3	103.3	- 15.0
	16	84.7	83.0	1.7
	17*	91.3	42.7	48.7
	18	81.7	58.3	23.3

No*: Patients who were diagnosed for strangulation with only visual assessment by radiologist.

Table 2. Comparison of Difference of HU of Bowel Wall between Strangulated and Non-strangulated Small Bowel Obstruction

	Strangulation	Non-strangulation
Mean (A-B)*	56.5	12.4
S.D.†	22.6	11.4

Student t-test: p < 0.001
*A-B: HU of well enhanced bowel wall - HU of poorly enhanced bowel wall in same patient, †S.D.: Standard Deviation

(n=5), (n=4) 가 (Table 3).

(n=1), (n=10), 가 (n=4), (n=3),

(n=5)

Fisher exact test (6, 7, 16, 17).

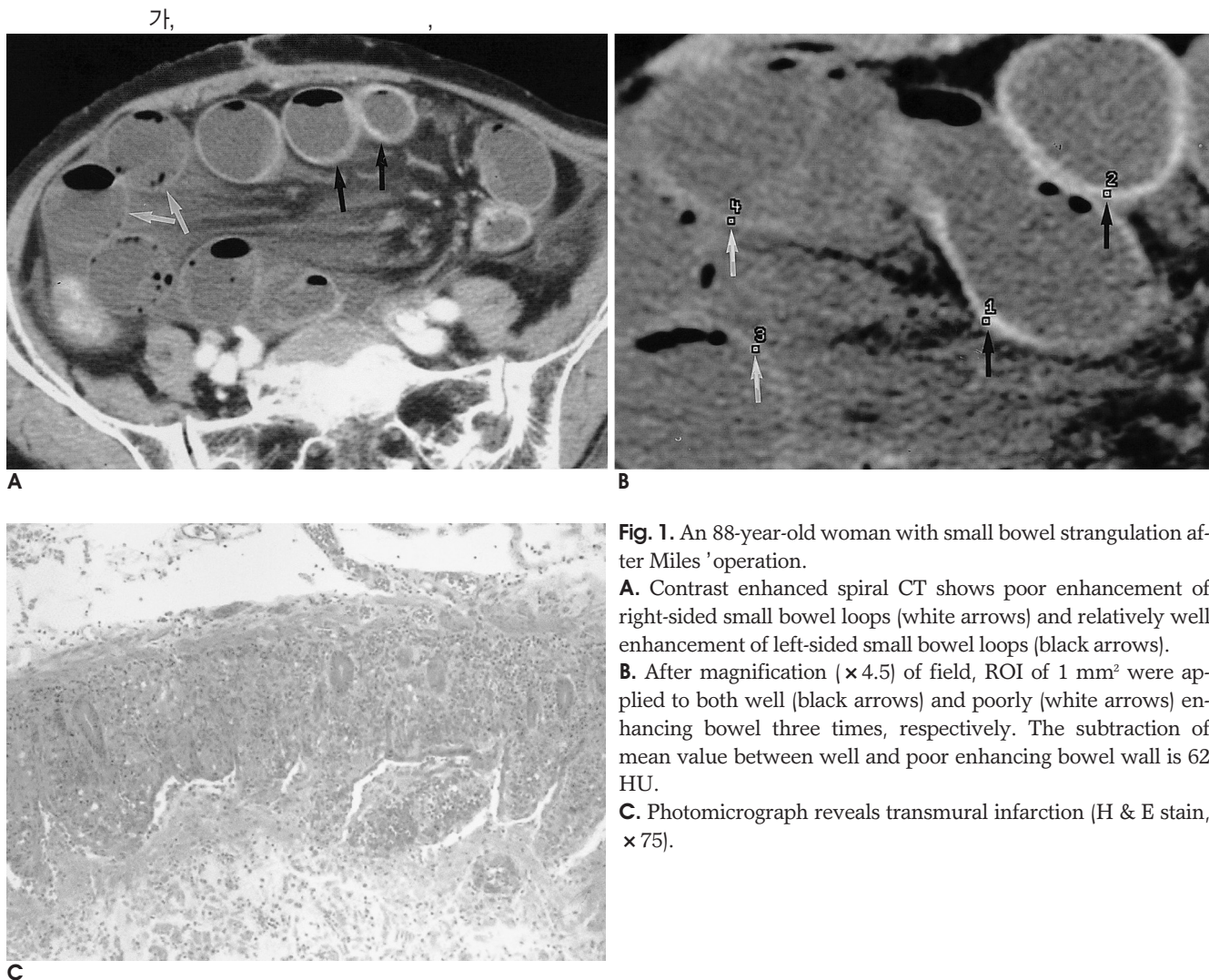
HU (가 25 HU)

p - value (p<0.001), ,

Table 3. CT Signs of Strangulated and Non-strangulated Small Bowel Obstruction

CT signs	Strangulation (n = 13)		Non-strangulation (n = 18)		p-value
	n	%	n	%	
Reduced Bowel Wall Enhancement					
Measure of HU*	13	100	1	5	<0.001
Visual Assessment	9	69	1	5	<0.001
Ascites	9	69	10	55	0.48
Thickening of Bowel Wall	5	38	4	22	0.43
Displacement of SMA [†]	5	38	3	16	0.23
Venous Engorgement	4	30	5	27	1.00

* Hounsfield Unit, [†]Superior Mesenteric Artery

**Fig. 1.** An 88-year-old woman with small bowel strangulation after Miles' operation.

A. Contrast enhanced spiral CT shows poor enhancement of right-sided small bowel loops (white arrows) and relatively well enhancement of left-sided small bowel loops (black arrows).

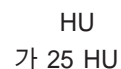
B. After magnification ($\times 4.5$) of field, ROI of 1 mm² were applied to both well (black arrows) and poorly (white arrows) enhancing bowel three times, respectively. The subtraction of mean value between well and poor enhancing bowel wall is 62 HU.

C. Photomicrograph reveals transmural infarction (H & E stain, $\times 75$).

(
75.8%)

(Fig. 1).

가 (22%)가 (98%)가
, Zalcman (7) ((75%, 75.8%)
(87.5%, 90%) 가 .
CT
(69%)
(44%)가 .
3 mm
2 mm
가 (17).
가 ,
, ,
Macari (17) (double
halo)
(16). CT 38%
83% .
(internal hernia) ,
(95%)
(72%) (17).
CT



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Usefulness of Helical CT in the Diagnosis of Strangulation in Small Bowel Obstruction¹

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Purpose: We wished to evaluate the usefulness of helical CT for the diagnosis of strangulation of the dilated small bowels.

Materials and Methods: The CT scans of 31 patients with small bowel obstruction from various causes were reviewed retrospectively. Thirteen of these patients were confirmed as small bowel strangulation by surgery and pathology. Fourteen patients underwent surgery, but they had no strangulation. Three patients were reduced by using a nasogastric tube and one infant with intussusception was reduced by air reduction. The following CT findings of strangulation were evaluated: reduced bowel wall enhancement by visual assessment and measuring the HU, ascites, thickening of bowel wall, abnormal mesenteric vessel location and whirlpool appearance, and mesenteric venous engorgement. For the precise evaluation of reduced bowel wall enhancement, the HUs were measured by 1 mm² of ROI, and the differences of HUs between the well enhanced bowel and poorly enhanced bowel were compared.

Results: For the diagnosis of strangulation, measurement of HU of the bowel wall could improve the sensitivity from 69% to 100%. The specificity of both methods, by visual assessment and measurement of HU, was 94%. Ascites had a sensitivity of 69% and specificity of 44%. Thickening of bowel wall had a sensitivity of 38% and specificity of 78%. Abnormal mesenteric vessel location and whirlpool appearance had a sensitivity of 38% and specificity of 83%. Mesenteric venous engorgement had a sensitivity of 31% and specificity of 72%.

Conclusion: Measurement of HU of the bowel wall after contrast enhancement can be a useful method in the differential diagnosis between the strangulated and non-strangulated bowels in patients with small bowel obstruction.

Index words : Intestines, CT

Intestines, infarction

Intestines, ischemia

Intestines, stenosis or obstruction

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