



Abstract

## Chest Radiographic Parameters of Mediastinal Hemorrhage in Patients with Traumatic Aortic Injury Patients

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**Background:** Traumatic rupture of the aorta is a life-threatening injury that must be diagnosed as rapidly as possible and treated immediately. The chest X-ray is a valuable tool for screening traumatic rupture of the aorta in blunt chest trauma. And various chest radiologic parameters are being used as diagnostic tools for aortic injury. The purpose of this study is to identify chest radiographic parameters that may assist in the detection of traumatic rupture of the aorta and to compare these findings with those of other reports.

**Methods:** This study involved 30 adult patients with traumatic rupture of the aorta seen at the emergency department of the Asan Medical Center from 1997 to 2004. The control subjects were 30 healthy patients with neither lung nor cardiovascular disease. We retrospectively assessed over 14 parameters on chest X-rays.

**Results:** In 11 of the 14 parameters, there were significant differences between the study group and the control group. There was no significant difference in the M/C ratio (mediastinum-to-chest width ratio) between the two groups, and neither the left nor the right paraspinal interface was statistically significant ( $p > 0.05$ ). Our study indicates that new criteria for the MC ratio and for the paraspinal interfaces are needed for screening traumatic aorta injury. The other radiographic parameters for traumatic rupture of the aorta need to be further assessed through a prospective study.

**Key Word:** Trauma, Aortic rupture, Radiography, Mediastinum, Hemorrhage

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: 2005 1 20 , : 2005 5 4 , : 2005 5 26

(3),  
 80%가 (4).  
 50 %가 24  
 16 ~ 23% (mediastinum to chest width ratio, M/C ratio), (right paratracheal stripe, RPS) (aortopulmonary window, APW) (aortography) (CT angiography) (apical cap sign) 20 가 (4,5).  
 가 (pseudocoarctation), 가 (2). (6,7).

**Table 1.** Known definition of chest radiographic parameters of mediastinal hemorrhage

Parameters	Definition
Mediastinal widening	80 mm at the level of the aortic arch
Increased M/C* ratio	0.25 at the level of the aortic arch
RPS <sup>†</sup> widening	5 mm at a level 2 cm above the superior extent of the azygos arch or “ vanishing azygos arch ”
APW <sup>‡</sup> obscuration	Opacification of the clear space between the aortic knob and the left pulmonary artery
Aortic knob widening	Maximal diameter of aortic knob 40 mm
Aortic knob blurring	Atypical contour or the outline is not clearly and sharply visible
Descending aorta widening	Increased convex contour or extended to lateral side of aortic knob
Descending aorta blurring	Atypical contour or the outline is not clearly and sharply visible
Ascending aorta widening	Increased curvature of the midright heart border or extended to lateral side of SVC border
Ascending aorta blurring	Atypical contour or the outline is not clearly and sharply visible
Apical cap sign	The upward extension of the mediastinal stripe coursing laterally at the top of the mediastinal space
LPI <sup>§</sup> widening	5 mm from left lateral border of vertebral body
RPI widening	5 mm from right lateral border of vertebral body
Trachea deviation to right.	The middle of the trachea extended to the right of the spinous process at T4/T5 in nonrotated image
NGT <sup>¶</sup> deviation to right	Above 1~2 cm extended to the right of the spinous process at T4/T5 in nonrotated image

\*; Mediastinal to chest width, <sup>†</sup>; right paratracheal stripe, <sup>‡</sup>; aortopulmonary window, <sup>§</sup>; left paraspinous interface, <sup>¶</sup>; right paraspinous interface, <sup>¶</sup>; nasogastric tube.

— : —

(Table 1).

1.

1997 10 2004 2

가

30

가 27

2004 3 13 30

20~60

2.

(chest AP view), PACS (Picture archiving and communicating system)

1, 18.1 1280 × 1024 (pixel) (Thin film transistor liquid crystal display, TFT-LCD) AMC PetaVision for Clinics

(sharpening), 가 (window level)

0.1 mm (Fig. 1).

3.

(apical cap sign)

SPSS 11.5 Fisher

가, (left paraspinal inter-

face, LPI), (right paratracheal interface, RPI)

ROC (Receiver operating characteristics) (cut-off value)

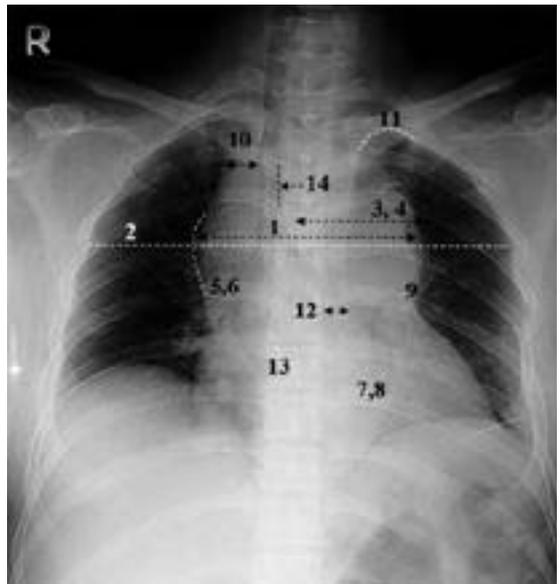
43.0 ± 12.7

: 24:6, 45.0 ± 9.5

: 14:16

가 26, 4 가

132.8 ± 32.3 mmHg,



**Fig. 1.** Chest radiographic parameters of traumatic aortic rupture. 1 (black bidirectional dotted arrow); mediastinal widening, 2; chest width for M/C ratio, 3, 4; aortic knob widening & blurring, 5, 6; ascending aorta widening & blurring, 7, 8; descending aorta widening & blurring, 9; aortopulmonary window obscuration, 10; right paratracheal stripe widening, 11; apical cap sign, 12; left paraspinal interface widening, 13; right paraspinal interface widening, 14; trachea deviation to right side. Also multiple rib fractures are seen on left side.

72.4±23.2 mmHg  
 90 mmHg  
 mmHg  
 16  
 27  
 1  
 가 2  
 (complete rupture)  
 8  
 3  
 가  
 (hopeless discharge)  
 rupture)  
 22  
 가  
 (p> 0.05).  
 27  
 가 20  
 가 4  
 (p<0.01)(Table 3).  
 102.71± 18.30 mm,  
 mm (p<0.01),  
 (M/C ratio) 0.418±0.675,  
 4 , 140  
 (Table 2).  
 5 ,  
 가  
 가  
 (partial  
 2  
 가  
 .  
 5/30 (16.6%)  
 (p<0.01).  
 가 15 ,  
 가  
 40 mm  
 (33.3%)  
 5 mm  
 0.280±0.032 (p<0.01).  
 58.83± 13.18 mm,  
 37.45±4.23 mm (p<0.01),  
 15.99± 8.53 mm,  
 2.68±1.04 mm (p<0.01).  
 23.40± 10.25 mm,  
 9.34±3.19 mm(p<0.01),  
 3.46± 4.17 mm,  
 Mann whitney  
 p 0.0911  
 가 (Table 4).  
 가 80 mm  
 25/27 (92.6%),  
 0.25  
 27/27 (100%)  
 26/30 (86.7%)  
 (p=0.114).  
 27/27(100%)  
 10/30  
 (p<0.01).

**Table 2.** Clinical characteristics and outcome of traumatic aortic injury patients

Characteristics	Partial rupture (n=20)	Complete rupture (n=7)	Total (n=27)
<b>Cause</b>			
Traffic accident	18 (90.0%)	7 (100.0%)	26 (96.3%)
Fall	4 (20.0%)	0 (0.0%)	4 (14.8%)
<b>Initial blood pressure</b>			
SBP* (mmHg)	134.4 ± 26.2	128.4 ± 43.6	132.8 ± 32.3
DBP†(mmHg)	75.0 ± 19.2	65.5 ± 32.2	72.4 ± 23.2
SBP<90 mmHg	2 (10.0%)	2 (28.6%)	4 (14.8%)
SBP 140 mmHg	13 (65.0%)	3 (42.9%)	16 (59.3%)
<b>Site of injury</b>			
Isthmus only	19 (95.0%)	6 (85.7%)	25 (92.6%)
Arch only	1 (5.0%)	1 (14.0%)	2 (7.4%)
Ascending only	0 (0.0%)	0 (0.0%)	0 (0.0%)
Isthmus + arch	2 (10.0%)	0 (0.0%)	2 (7.4%)
Isthmus + ascending	0 (0.0%)	0 (0.0%)	0 (0.0%)
Arch + ascending	0 (0.0%)	1 (14.3%)	1 (3.7%)
Isthmus +arch + ascending	0 (0.0%)	0 (0.0%)	0 (0.0%)
<b>Outcome</b>			
Expire/hopeless discharge	2 (10.0%)	3 (42.9%)	5 (18.5%)
Discharge	18 (90.0%)	5 (71.4%)	25 (92.6%)

\*; systolic blood pressure, †; diastolic blood pressure

16/16 (100%), 20/21 (95.2%) 50%(6/12 ), 67%(18/27 ), 70%(19/27 )  
 가 (p=1.00),  
 5 mm  
 5/18 (27.7%), 1/13 (7.7%)  
 (p=0.359).  
 가  
 (Table 3, 4). ROC  
 (Fig. 2). (cut-off  
 41%(11/27 ), value) 13.7 mm 0.95

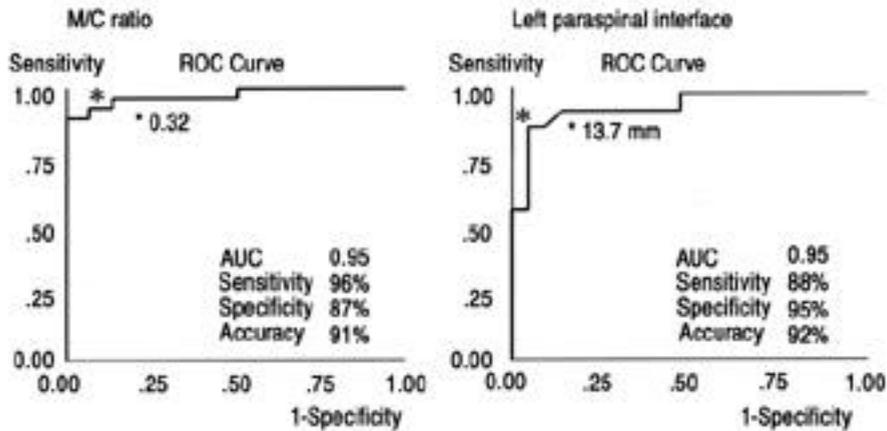
**Table 3.** Statistical analysis of radiographic findings in aortic injury group and control group

Plain chest AP view	Patient group (n= 27)	Control group (n=30)	Sensitivity (%)	Specificity (%)	Accuracy (%)	p value
<b>Measured data*</b>						
Mediastinal width (mm)	102.71 ± 18.30	69.33 ± 8.79	-	-	-	<0.01
RPS <sup>†</sup> width (mm)	15.99 ± 8.53	2.68 ± 1.04	-	-	-	<0.01
M/C <sup>‡</sup> ratio	0.418 ± 0.068	0.280 ± 0.032	-	-	-	<0.01
Aortic knob width (mm)	58.83 ± 13.18	37.45 ± 4.23	-	-	-	<0.01
<b>Adequacy of X-ray</b>						
Inadequate inspiration	20 (74.0%)	3 (10.0%)	74	90	82	<0.01
Rotation	15 (55.0%)	7 (23.0%)	56	77	67	0.016
<b>Parameters</b>						
Descending aorta blurring	25 (92.0%)	0 (0.0%)	93	100	96	<0.01
RPS <sup>†</sup> widening	25 (92.0%)	1 (3.0%)	93	97	95	<0.01
Aortic knob blurring	25 (92.0%)	1 (3.0%)	93	97	95	<0.01
APW <sup>§</sup> obscuration	27 (100.0%)	4 (13.0%)	100	87	93	<0.01
Descending aorta widening	24 (88.0%)	4 (13.0%)	89	87	88	<0.01
Apical cap sign	19 (70.0%)	0 (0.0%)	100	79	86	<0.01
Ascending aorta blurring	18 (66.0%)	0 (0.0%)	67	100	84	<0.01
Aortic knob widening	27 (100.0%)	10 (33.0%)	100	67	82	<0.01
Mediastinal widening	25 (92.6%)	5 (16.0%)	74	90	82	<0.01
Ascending aorta widening	11 (40.7%)	1 (3.0%)	41	100	71	<0.01
M/C <sup>‡</sup> ratio > 0.25	27 (100.0%)	26 (86.0%)	100	13	54	0.114
Clavicle fracture	1 (3.7%)	0	-	-	-	-
Rib fracture (1st, 2nd)	5 (18.5%)	0	-	-	-	-
Hemothorax	25 (92.6%)	0	-	-	-	-
Pneumothorax	4 (14.8%)	0	-	-	-	-

\*Means were tested by Mann Whitney test, other variables were tested by Fisher exact test. <sup>†</sup>RPS; right paratracheal stripe, <sup>‡</sup>M/C; Mediastinal to chest width, <sup>§</sup>APW; aortopulmonary window.

88%, 95%, 91%  
0.32  
0.95 96%, 87%, 92%  
(p<0.01)(Table 5).

가 가  
5  
1 (Fig. 3), 25/27 (transesophageal  
(92.6%), 4/27 (14.8%), 1/27 echocardiography, TEE)  
(3.7%), (1, 2) 5/27  
(18.5%) 가  
1/5 (20%),  
6/12(50%) (Table 3, 4).



**Fig. 2.** ROC curve of mediastinal to chest width ratio and left paraspinal interface. M/C; mediastinal to chest width, AUC; area under the curve. M/C ratio has 91% accuracy at 0.32, left paraspinal interface has 92% accuracy at 13.7 mm.

**Table 4.** Radiographic findings which were not checked in all patients

Parameters	Patient	Control	Sensitivity (%)	Specificity (%)	Accuracy (%)	p value
Means <sup>†</sup>						
LPI <sup>‡</sup> width (mm)	23.40 ± 10.25	9.34 ± 3.19	-	-	-	<0.01
RPI <sup>§</sup> width (mm)	3.46 ± 4.17	1.00 ± 1.79	-	-	-	0.091
Parameters						
Trachea deviation to right	6/12 (50.0%)	0 (0.0%)	50	100	83	<0.01
RPI <sup>‡</sup> widening	5/18 (27.7%)	1/13 (7.7%)	28	92	55	0.359
LPI <sup>‡</sup> widening	16/16 (100.0%)	20/21 (95.2%)	100	5	46	1.00
NGT deviation to right	1/5 (20.0%)	0 (0.0%)	20	-	-	-

<sup>†</sup>; Means were tested by Mann Whitney test, other variables were tested by Fisher exact test. <sup>‡</sup>LPI; left paraspinal interface, <sup>§</sup>RPI; right paraspinal interface, NGT; nasogastric tube,

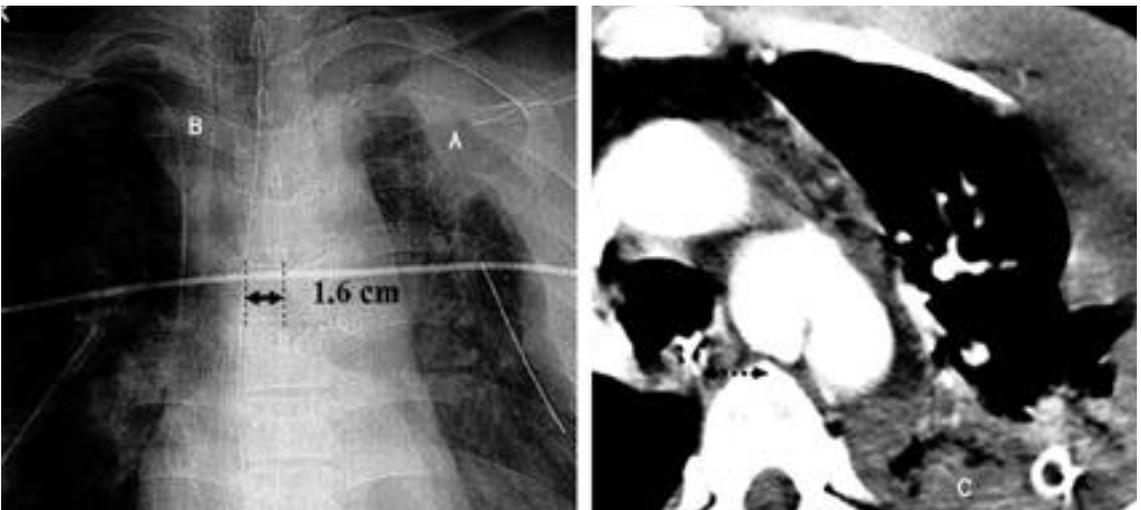
(6). TEE (7-9). 20 가  
 가 가 , 가 ,  
 . CT

가 (8,10-18). Marsh(11)  
 , Tisnado(12)  
 Gerlock(8) ,  
 Mirvis(13) - ;  
 Heystraten(14) ;  
 Simeone(15) , Seltzer(16)

**Table 5.** Statistical result of new of M/C\* ratio increase & LPI<sup>†</sup> widening criteria

Plain chest AP view parameter	Sensitivity (%)	Specificity (%)	Accuracy (%)	p value
M/C*ratio				
> 0.25	100	13	54	0.114
> 0.32	96	87	91	<0.01
LPI <sup>†</sup>				
> 5 mm	100	5	44	1.00
> 13.7 mm	88	95	92	<0.01

\* M/C; Mediastinal to chest width, <sup>†</sup>LPI; left paraspinal interface



**Fig. 3.** A case of nasogastric tube deviation to the right side on chest X-ray. The distance from nasogastric tube to the spinous process at T4,5 level is about 1.6 cm. Nasogastric tube is seen as an artifact image within esophagus on CT image. In this patient, (A) apical cap sign, (B) right paratracheal stripe widening, (C) left hemothorax are also seen.

0.25 가  
 Woodring(17) 가  
 가 , Gerlock(8) 가  
 가 Fisher(18) 1 , Gerlock(8) 5  
 , Harris(10) 75% Tisnado(12) 100%  
 가  
 PACS 가 11가  
 ROC  
 가  
 가

REFERENCES

가 ROC 0.32  
 96%, 87%,  
 92%  
 13.7 mm  
 88%, 95%, 91%  
 가  
 가  
 (10).  
 가

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