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ORIGINAL ARTICLE

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The diagnostic accuracy of the mediastinal width on supine anteroposterior chest radiographs with nontraumatic Stanford type A acute aortic dissection

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Abstract

Background: Nontraumatic Stanford type A acute aortic dissection is a life-threatening condition; thus, the ability to make a precise diagnosis of nontraumatic Stanford type A acute aortic dissection is essential for the emergency physician. Several reports have shown that the mediastinal widening on a chest radiograph is useful for the diagnosis of nontraumatic Stanford type A acute aortic dissection; however, the exact cutoff value of the mediastinal width on plain radiographs is rarely defined.

Methods: A single-center retrospective case-control study was conducted between October 1, 2013, and March 31, 2015. We evaluated the maximal mediastinal width of the anteroposterior chest X-ray at the level of the aortic knob in the supine position between patient groups with and without nontraumatic Stanford type A acute aortic dissection.

Results: We enrolled 72 patients (36 patients with nontraumatic Stanford type A acute aortic dissection and 36 patients without nontraumatic Stanford type A acute aortic dissection). The median mediastinal width of patients with nontraumatic Stanford type A acute aortic dissection was significantly larger than that of patients without nontraumatic Stanford type A acute aortic dissection (100.7 mm vs 77.7 mm, $P < .01$). The optimal cutoff level was 87 mm (sensitivity, 81%; specificity, 89%). Using multivariable logistic regression, the odds ratio of a mediastinal width of >87 mm for a diagnosis nontraumatic Stanford type A acute aortic dissection was 57.1 (95% confidence interval, 11.2-290.2).

Conclusion: A mediastinal width of >87 mm showed high sensitivity in the diagnosis of probable nontraumatic Stanford type A acute aortic dissection.

KEYWORDS

aorta, dissection, imaging, radiography

1 | INTRODUCTION

Nontraumatic Stanford type A acute aortic dissection (NTAD) is a life-threatening condition. Without intervention, the mortality rates at 48 hours and 2 weeks from onset are 50% and 80%, respectively.[1] Typically, NTAD patients are presented with sudden onset chest pain or migrating back pain; however, some patients are presented with symptoms such as dyspnea, hemiplegia, or dizziness.[2] Computerized tomography (CT) with the intravenous (IV) contrast has been the gold standard in the diagnosis of NTAD; one study reported that the diagnostic accuracy of CT with IV contrast for NTAD was 100%.[3] However, it is not feasible to perform CT scans to investigate possible NTAD in all patients with chest pain because chest pain is a very common symptom among patients who present to emergency departments.[4] Especially in rural resource-limited area, transportation to another hospital is needed to perform CT scan. Thus, when we evaluate a patient with chest pain or back pain, we need to accurately estimate the probability of NTAD to avoid unnecessary CT.

Although a wide mediastinum width was found to display high sensitivity in the detection of NTAD in several studies, the measurement can be provider dependent. The exact cutoff value of the mediastinal width on plain radiographs is rarely defined in those reports.[5] To evaluate a cutoff mediastinum width for the diagnosis of NTAD, differences in the physical sizes of different races should be considered. In addition to racial differences, we should consider the patient's posture. Because unstable patients with possible NTAD are usually examined in the supine position, we should investigate chest radiographs that are taken in the supine position. However, there are few studies that investigate the mediastinal width on supine anteroposterior chest radiographs of Japanese patients with NTAD.[6,7]

This study was performed to address this knowledge gap and to define the cutoff value for estimating mediastinal widening among Japanese patients.

2 | MATERIALS AND METHODS

2.1 | Study design

This retrospective case-control study was conducted in Tokyo Bay Urayasu Ichikawa Medical Center, a 344-bed urban acute care community hospital in Eastern Tokyo, Japan. This institution is a regional cardiovascular center that is capable of performing cardiothoracic surgery 24 hours per day. The study was reviewed and approved by the local Institutional Review Board. The institutional review board waived the requirement for patient consent because of the retrospective nature of the study.

2.2 | Patient selection

All of the acute NTAD patients who were treated from October 1, 2013, to March 31, 2015, were eligible for inclusion in this study. We also selected the same number of patients without aortic dissection, admission, or any surgery who presented to our emergency department during the study period using simple random sampling to create a matching control group. In all cases, the diagnosis of NTAD was confirmed by CT with and without IV contrast.

We exclude the patients who did not undergo a chest X-ray due to emergency thoracotomy, those with a known history of thoracic aortic aneurysm, aortic dissection, mediastinal disease, central lung disease obscuring the mediastinum, prior thoracic surgery, a history of trauma, or in whom significant torsion was observed on a chest X-ray. The height, body weight, body mass index (BMI), gender, age, and mediastinal width were evaluated in all patients.

2.3 | Imaging techniques and measurement

The radiographic technique involved a 100-cm source-image distance, 60-70 kV peaks, and a typical 6-7 mA exposure adjusted to the body habitus. Each radiograph was processed in a standard rapid processor with a processing time of 45 seconds. The use of wireless X-ray exposure synchronization technology enabled the X-ray films to be reviewed at the bedside. This technology enabled us to obtain another image immediately if the image quality was poor until adequate X-ray was taken. We defined the X-ray as poor quality when the spinous processes are not in the midline of the vertebral body. This strict quality assurance provided by this procedure meant that variations due to patient positioning, angle, exposure, and film distance were minimal. Four independent board-certified emergency physicians who were blinded to the diagnosis of films reviewed the chest radiographs and measured the mediastinal width. All physicians were given a lecture from board-certified radiology physician to minimize interpersonal reliability.

The mediastinal width was defined, based on a previous study, as the maximal distance from the right lateral border to the left lateral border of the superior mediastinum at the level of the aortic knob.[7] Figure 1 is the sample X-ray that showed how we measured the mediastinal width.

2.4 | Statistical analysis

We compared proportions and continuous variables using the chi-squared test and the Mann-Whitney *U* test, respectively. We generated a receiver operating characteristic (ROC) curve with cutoff values along the curves to determine the best diagnostic accuracy. The best Youden index was used to determine the best cutoff point.

The patients who were divided into two groups based on age (<65 years of age and ≥65 years of age). We also divided the patients into two groups based on their BMI values (BMI < 25 and BMI ≥ 25). A multivariate logistic regression analysis adjusted for age, gender, BMI, and mediastinal width was performed to analyze the relationships between the mediastinal width and NTAD.

P values of <.05 were considered to indicate statistical significance. All of the statistical analyses were performed using the IBM SPSS software program (version 22, IBM Corp, Armonk, NY, US).

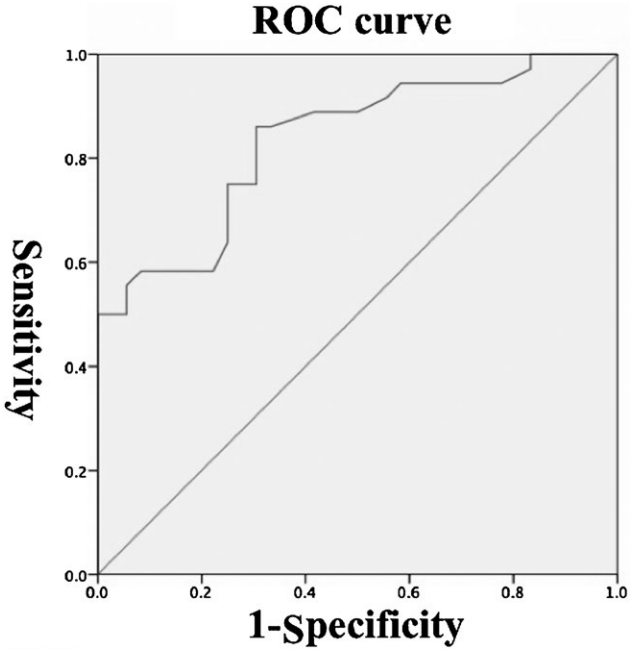

FIGURE 1 The receiver operating characteristic (ROC) curves for the diagnosis of nontraumatic aortic dissection

2.5 | Sample size calculation

We planned this study of a continuous variable from independent both group. Considering a true difference in the NTAD group and non-NTAD group of 15 mm in anteroposterior chest radiograph based on previous study, we needed at least 17 patients in each group to be able to reject the null hypothesis that the population means between two groups were equal with probability (power) 0.80. The type I error probability associated with this test of this null hypothesis was 0.05 (α).

3 | RESULTS

During the study period, 36 patients were diagnosed with NTAD. One patient who required emergent surgery without a chest radiograph was excluded based on the previously mentioned exclusion criteria. No other patients were excluded from this study. Thirty-six patients were selected for the control group.

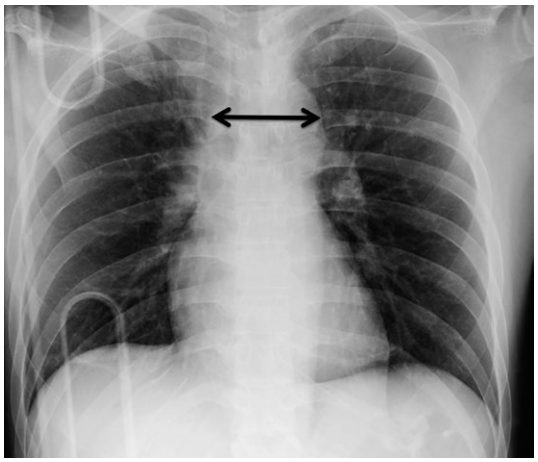

FIGURE 2 A sample image to show how we measured the mediastinal width

Table 1 shows the characteristics of the patients. There were no significant differences in the age, gender, or BMI of the two groups. However, the median mediastinal width of the patients with NTAD was significantly larger than that of the patients without NTAD. The intraclass correlation coefficient in the measurement of mediastinal width was 0.86 (95% Confidence Interval [CI]; 0.78-0.91) that was considered that reliability of measurement was acceptable level.

The Youden index and the area of the ROC curve at the cutoff point for NTAD are presented in Figure 2. The area under the curve was 0.89 (95% CI; 0.81-0.96, $P < .01$). The sensitivity and specificity of the best cutoff point (87 mm) were 81% and 89%, respectively.

To analyze the relationship between a mediastinal width of >87 mm and the diagnosis of NTAD, we developed a multivariable logistic regression model that was adjusted for age, gender, and BMI. After adjustment, we found that a mediastinal width of >87 mm was independently associated with a higher proportion of NTAD diagnoses (odds ratio 57.1 95% CI 11.2-290.2) (Table 2).

4 | DISCUSSION

The median mediastinal width of the patients with NTAD was significantly larger than that of the control group. When we set a cutoff point of 87 mm, the sensitivity and specificity were 86% and 69%, respectively. A multivariable logistic regression analysis revealed that

TABLE 1 Patient characteristics

	Total	NTAD group	Control group	*P*
Male gender, n (%)	45 (62.5%)	20 (55.6%)	25 (69.4%)	.22
Median age (IQR)	69 (55-80)	69.5 (55.8-77.3)	68 (54.5-81.5)	.06
Median BMI (IQR)	21.9(18.9-25.1)	21.1 (19.5-24.0)	22.6 (18.9-25.4)	.15
Median Mediastinal width (IQR)	87 (77.5-96.5)	92 (82-114.8)	81 (76-90.5)	<.01
Median height (IQR)	162 (154-170)	160.5 (154.5-171.8)	163 (154-166)	.08
Median body weight (IQR)	57 (45-68.5)	56 (44.5-67)	59 (46-70.5)	.50

BMI, body mass index; NTAD, nontraumatic aortic dissection; SD, standard deviation.

TABLE 2 Odds ratios for the diagnosis of NTAD as determined by multivariable logistic regression

Variables	Adjusted odds ratio (95% CI)	*P*
Female gender	2.90 (0.67-12.5)	.15
Age >65 y	0.21 (0.45-1.02)	.053
BMI >25	0.28 (0.83-2.04)	.28
Mediastinal width >87 mm	57.1 (11.25-290.25)	<.01

BMI, body mass index; CI, confidence interval; NTAD, nontraumatic aortic dissection; SD, standard deviation.

the odds ratio for a mediastinal width of >87 mm for the diagnosis of NTAD was 57.1.

Computerized tomography with IV contrast is essential for the accurate diagnosis of NTAD. However, CT itself involves a high degree of radiation and is associated with high medical costs.[8] In addition, the use of IV contrast may cause an allergic reaction or contrast-induced nephropathy.[9] We should therefore avoid the use of CT when it is not necessary through the circumspect consideration of each case.

Recent studies have shown the D-dimer level (as determined by an enzyme-linked immunoassay [ELISA]) to be a highly sensitive in the diagnosis of aortic dissection; the D-dimer level has therefore been used to rule out NTAD in some departments.[10] However, in Japan, only a limited number of hospitals are capable of evaluating the D-dimer level in a timely manner. Thus, mediastinal widening is still important in ruling out NTAD especially in rural area.

Our results were similar to those of recent studies. However, it is important that we avoid relying too heavily on the assessment of the mediastinal width because it is well known that it is affected by intraobserver and interobserver differences.[11,12]

The ROC curve showed that a mediastinal width above 96 mm had 100% specificity. These results suggested that a CT scan should be considered for the patients with the mediastinal width of >96 mm, even if the patients with chest pain presented the atypical clinical history or physical examination for NTAD. On the other hand, 13 patients had mediastinal width below 87 mm and the narrowest width was 67 mm which is observed at the smallest patient in NTAD group. Based on this fact, we should not hesitate a CT scan when the patients were suspected to have NTAD even if the mediastinal width was below 87 mm because NTAD is a critical disease not to be overlooked.

4.1 | Limitations

Although the population pyramid of Urayasu Ichikawa Area is quite similar to that of the national population and despite the adequacy our sample size was, one of the limitations of our study design was that the study was conducted at a single community hospital in Japan. This may limit the generalizability of the results. A larger multicenter study would be needed to confirm the present findings. Second, although we examined the BMI, age, and gender, other factors that are associated with the mediastinal width were not investigated; large body habitus, chronic obstructive pulmonary disease, mediastinal hematoma, or entry of the dissection, for example, may influence the mediastinal width. However, we do not have any firm evidence to indicate the factors that contribute to the mediastinal width.

5 | CONCLUSION

Among Japanese patients with possible NTAD, a mediastinal width of >87 mm showed high sensitivity, while a width of >96 mm showed high specificity. Further prospective nationwide trials are needed to determine the best cutoff value.

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CONFLICT OF INTEREST

The authors have stated explicitly that there are no conflicts of interest in connection with this article.

DISCLOSURE

The protocol for this research project has been approved by a suitably constituted Ethics Committee of the local institution, and it conforms to the provisions of the Declaration of Helsinki. The institutional review board waived the requirement for patient consent because of the retrospective nature of the study. All authors declare no conflict of interests in association with this study.

REFERENCES

1. Coady MA, Rizzo JA, Goldstein LJ. Natural history, pathogenesis, and etiology of thoracic aortic aneurysms and dissections. Cardiol Clin. 1999;17:615–35.
2. Klompas M. Does this patient have an acute thoracic aortic dissection? JAMA. 2002;287:2262–72.
3. Yoshida S, Akiba H, Tamakawa M, et al. Thoracic involvement of type A aortic dissection and intramural hematoma: diagnostic accuracy–comparison of emergency helical CT and surgical findings. Radiology. 2003;228:430–5.
4. Boie ET. Initial evaluation of chest pain. Emerg Med Clin North Am. 2005;23:937–57.
5. von Kodolitsch Y, Schwartz AG, Nienaber CA. Clinical prediction of acute aortic dissection. Arch Intern Med. 2000;160:2977–82.
6. Hazui H, Fukumoto H, Negoro N, et al. Simple and useful tests for discriminating between acute aortic dissection of the ascending aorta and acute myocardial infarction in the emergency setting. Circ J. 2005;69:677–82.
7. Lai V, Tsang WK, Chan WC, Yeung TW. Diagnostic accuracy of mediastinal width measurement on posteroanterior and anteroposterior chest radiographs in the depiction of acute nontraumatic thoracic aortic dissection. Emerg Radiol. 2012;19:309–15.
8. Kruger JF, Chen AH, Rybkin A, et al. Displaying radiation exposure and cost information at order entry for outpatient diagnostic imaging: a strategy to inform clinician ordering. BMJ Qual Saf. 2016;25:977–85.

9. Weisbord SD, Palevsky PM. Radiocontrast-induced acute renal failure. J Intensive Care Med. 2005;20:63–75.
10. Asha SE, Miers JW. A Systematic review and meta-analysis of D-dimer as a rule-out test for suspected acute aortic dissection. Ann Emerg Med. 2015;66:368–78.
11. Jagannath AS, Sos TA, Lockhart SH, Saddekni S, Sniderman KW. Aortic dissection: a statistical analysis of the usefulness of plain chest radiographic findings. AJR Am J Roentgenol. 1986;147:1123–6.
12. Luker GD, Glazer HS, Eagar G, Gutierrez FR, Sagel SS. Aortic dissection: effect of prospective chest radiographic diagnosis on delay to definitive diagnosis. Radiology. 1994;193:813–9.

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