Diagnostic Score to Differentiate Acute Aortic Dissection in the Emergency Room

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Background  Acute aortic dissection (AAD) is a life-threatening cardiovascular disorder that is similar to acute coronary syndrome (ACS), which means differentiating AAD and ACS is sometimes difficult in an emergency. Methods and Results  Specific information from 131 patients with AAD or ACS was analyzed between April 2001 and March 2002. The emergency room AAD (ERAAD) score was defined as the total number of specific indexes for AAD among 15 indexes that were obtainable in the emergency room (Study 1). The clinical applicability of the ERAAD score was also investigated in another 711 patients with AAD or ACS between April 2002 and March 2006 (Study 2). The ERAAD score was based on (1) presence of back pain, (2) mediastinal thoracic ratio >30%, (3) aortic regurgitation and (4) aortic diameter >30 mm on ultrasonography in Study 1. The ERAAD score was significantly higher in patients with AAD than with ACS (3.19±0.83 vs 1.17±0.99) in Study 2. The sensitivity and specificity for AAD were 93.1% and 77.6%, respectively, when the ERAAD score was ≥3. Conclusion  The ERAAD score enables clinical diagnosis of AAD and correct treatment.  

Key Words:  Aortic dissection; Diagnosis; Emergency room; Myocardial infarction

Methods

Study Design

Study 1  In order to define the features of AAD and ACS we evaluated 131 patients with AAD or ACS who were admitted between April 2001 and March 2002. The clinical information included age, gender, presence of back pain, systolic and diastolic blood pressures (BP), serum creatine kinase level, ST-T segment changes on electrocardiograms (ECG), mediastinum thoracic ratio (MTR; Fig 1) and cardiothoracic ratio (CTR) on chest X-rays, and aortic regurgitation (AR) and aortic diameter on ultrasonograms, as well as history of smoking, hypertension, hyperlipidemia or diabetes mellitus. We scored the total number of indexes specific to AAD for each patient to obtain the ERAAD score.

Fig 1. Mediastinum thoracic ratio (MTR). MTR = (a+b)/c.
We investigated the clinical applicability of the ERAAD score in another 711 patients with AAD or ACS who were admitted between April 2002 and March 2006. We determined the ERAAD score for each patient, and evaluated the sensitivity, specificity, and positive and negative predictive values for differentiating AAD from ACS.

**Statistical Analysis**

All numerical data are expressed as mean±standard deviation. Data were statistically analyzed using Student’s t-test and Fisher’s exact test for comparisons between AAD and ACS, and a p-value<0.05 was defined as statistically significant. The significant indexes for differentiating AAD and ACS were determined by multivariate logistic regression. Receiver-operating characteristic (ROC) curve analysis was used to determine the cutoff values of continuous variables. All data were analyzed using StatView 5 software for Windows (SAS Institute, Cary, NC, USA), and SPSS 14.0 J for Windows (SPSS Japan Institute, Tokyo, Japan).

**Results**

**Study 1**

We evaluated 15 indexes for AAD and ACS (Table 1), and found that back pain, MTR and CTR on chest X-ray, AR and aortic dilatation on ultrasonography were statistically significant (p<0.0001) and specific to AAD. The results from the multivariate logistic regression model for indicating AAD found that the specific indexes for AAD comprised back pain, MTR on chest X-ray, AR and aortic dilatation on ultrasonography, and hyperlipidemia (Table 2). The cutoff values of large MTR and aortic dilation were the highest at 30.55% (sensitivity 76.1%, specificity 75.5%) and 32.2 mm (sensitivity 67.3%, specificity 72.0%), respectively, by ROC curve analysis. We determined that the cutoff values for large MTR and aortic dilation were 30.0% and 30 mm. The degree of AR in ACS patients was severe in 1 (0.8%), moderate in 9 (7.7%), mild in 7 (5.9%), trace in 8 (6.8%), and none in 93 (78.8%), whereas the results for the AAD patients were moderate in 4 (30.8%), mild in 4 (30.8%), trace in 2 (15.4%), and none in 3 (23.0%). By ROC curve analysis, the highest sensitivity and specificity values to differentiate AAD from ACS were 76.9% and 70.47%.
80.3%, respectively, when the cutoff value for the degree of AR was defined as trace or more. We therefore selected the following indexes for calculating the ERAAD score: (1) back pain, (2) large MTR (>30%), (3) AR, and (4) aortic dilation (aortic diameter >30 mm).

Study 2

The characteristics of the patients evaluated in Study 2 were similar to those in Study 1 (Table 3), but the distribution of the ERAAD score was significantly higher in patients with AAD than in those with ACS (3.19±0.83 vs 1.1±0.99; Fig 2). The sensitivity and specificity for AAD were 93.1% and 77.6%, respectively, with an ERAAD score ≥3 (AAD, 52; ACS, 44). The positive and negative predictive values were 54.1% and 97.6%, respectively.

Discussion

Diagnosis of AAD

AAD is a frequent cardiovascular emergency. Meszaros et al8 followed up 106,500 individuals and identified 86 with AAD, representing an incidence of 2.9/100,000/year. They found that 18 of the 86 AAD patients died before admission to hospital (21.4%), and that the pre-admission death rate was 0.62/100,000/year. Many general practitioners are unaware of how to diagnose and treat AAD, thus complicating the initial diagnosis in the ER unless a cardiologist is present.

There are recent reports of 3–9% of patients with type-A AAD complicated with ACS;6,9–13 and Nakashima et al reported an incidence of 3–7% in an analysis of autopsies.10 When AAD causes ACS, the features of AAD are masked by those of ACS, making it more difficult to reach a correct diagnosis in the ER. In our experience at Chiba Hokusoh Hospital, 8 of 81 patients with AAD also had ACS (9.88%), which is more frequent than previously reported, indicating that only 0.26% of patients with ACS are diagnosed with AAD.14 Sullivan et al1 and Spittell et al2 found that the rate of correctly diagnosing AAD in the ER was 40–60% and 62%, respectively.

If ECG, biochemical cardiac markers and ultrasonography in the ER have indicated a diagnosis of ACS, we usually do not perform enhanced CT, in order to avoid injecting more contrast medium. Even if ACS is indicated by ECG in the ER, CAG must be performed after excluding AAD using cardiac ultrasonography, chest X-rays, and precise evaluations of clinical features and examinations. Cardiologists often clinically diagnose ACS in the ER, while rarely regarding it as a complication of AAD. Guidelines that should be followed in the ER have not been established, and performing enhanced CT in all patients with chest pain or ST-T segment changes is impractical.15 Thus, we propose using the ERAAD score for a more precise and non-invasive diagnosis.

Components of the ERAAD Score

Sullivan et al reported the importance of back pain for early diagnosis in the ER! If chest or back pain is the chief complaint, the rate of AAD suspected by ER physicians is 86%; however, when pain is absent the rate is only 15%. Rizzo et al reported that 74–90% of patients with AAD have back pain.16 In the present study, 71 of 761 ACS and 60 of 81 AAD patients presented with back pain, and the differences were statistically significant. In general, almost all patients with type-A AAD present with back or chest pain,15,16 so we selected back pain as 1 component of the ERAAD score.

A large MTR on chest X-ray indicates a very high probability of AAD. Klompas reported that the rate of mediastinum dilation in AAD is 24–81%17 and Elefteriades et al reported a rate of 81–90%.18 However, neither of those...
reports defined the criteria for dilation. Hazui et al found that the MTR was enlarged (>30%) more frequently in patients with AAD than in those with ACS. In the present study we found that 30% MTR enlargement was statistically significant, and thus included this factor in the ERAAD score.

Braverman et al reported that although ultrasonography is practical for screening AAD, its sensitivity and specificity of diagnosing AAD in the ER were 59–88% and 63–96%, respectively. Thus, AAD cannot be unequivocally diagnosed only by cardiac ultrasonography, and specific findings with this imaging technique have not been defined. Pericardial effusion and an intimal aortic flap are quite frequent in patients with AAD, but they are sometimes missed when ACS is suspected. The presence of an intimal flap, AR, and dilation of the aorta should be determined during ultrasonography. When AAD is not apparent, these signs are easy to miss. To avoid such misdiagnoses, we perform cardiac ultrasonography at the upper intercostal space. Others have shown a 60–70% incidence of AR in type-A AAD but once again, distinct criteria have not been defined. When a wide aortic diameter is defined as ≥30 mm, this parameter is seen more frequently on cardiac ultrasonography of patients with AAD than in those with ACS. Keane et al reported that the degree of AR in type-A AAD was severe in 17%, moderate in 24%, mild in 35%, trace or none in 26%. It is important in the management of type-A AAD patients to estimate the severity of AR, but it was not used for the ERAAD score based on the result of Study 1, which included type-B AAD patients. Therefore, we included wide aortic diameter and presence of AR as the ultrasonographic parameters in the ERAAD score.

We did not include a history of hypertension or high BP in the ERAAD score because BP is almost always high in patients with AAD and found a 70% incidence of AR in type-A AAD, but in the present study type-B AAD (DeBakey IIIb+) caused ACS in 3 of patients. Physicians should immediately operate when patients present with type-A AAD (patent type) or AAD with organ ischemia. When AAD causes ACS, the immediate priority is to save the life of the patient by reversing the myocardial ischemia. When immediate surgery is not an option, percutaneous coronary intervention (PCI) using a perfusion catheter and coronary stent can lessen myocardial ischemia. In our series, 3 patients underwent immediate surgery and only 1 underwent preoperative PCI.

Ikedo et al reported that the mortality rate of 8 patients with AAD complicated with ACS was 50%. The mortality rates of AAD complicated with ACS and of AAD alone reported by Kawada et al are 53% and 19%, respectively, and those reported by Kawahito et al are 33% and 8.8%, respectively. Both reports show significantly higher mortality rates among patients with complications than in those without. In the present study, 3 of 8 patients who had AAD with ACS died, giving a mortality rate of 38%. Whereas AAD rarely causes ACS, the presence of AAD should be considered when diagnosing ACS in the ER because immediate surgery is required when type-A AAD is the cause of the ACS.

Because excessive administration of contrast media should be avoided when CT of the aorta is to be followed by coronary angiography and catheter intervention, enhanced CT is not mandatory. The ERAAD scores of the 8 AAD patients complicated with ACS were ≥3 in all cases, so the score was able to clinically determine AAD patients complicated with ACS.

In conclusion, the new cost-effective, noninvasive and rapid ERAAD diagnostic score was clinically useful for diagnosis and then selection of an appropriate treatment strategy for patients with AAD and/or ACS. An ERAAD score ≥3 suggests AAD and enhanced CT before coronary angiography and catheter intervention should be considered to determine the presence of AAD in a patient with ACS.
References


