

# Clinical profiles and outcomes of acute type A aortic dissection and intramural hematoma in the current era: lessons from the first registry of aortic dissection in China

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## Abstract

**Background:** Acute type A aortic dissection (ATAAD) and acute type A intramural hematoma (ATAIMH) are life-threatening diseases with high mortality. To better understand their clinical features in the Chinese population, we analyzed the data from the first Registry of Aortic Dissection in China (Sino-RAD) to promote the understanding and management of the diseases.

**Methods:** All patients with ATAAD and ATAIMH enrolled in Sino-RAD from January 1, 2012 to December 31, 2016 were involved. The data of patients' selection, history, symptoms, management, outcomes, and postoperation complications were analyzed in the study. The continuous variables were compared using the Student's *t* test for normal distributions and the Mann-Whitney *U* test for non-normal distributions. Categorical variables were compared using the Chi-square test or Fisher exact test.

**Results:** A total of 1582 patients with ATAAD and 130 patients with ATAIMH were included. The mean age of all patients was 48.4 years. Patients with ATAAD were significantly younger than patients with ATAIMH (48.9 years *vs.* 55.6 years,  $P < 0.001$ ). For the total cohort, males were dominant, but the male ratio of patients with ATAAD was significantly higher compared to those with ATAIMH ( $P = 0.01$ ). The time range from the onset of symptom to hospitalization was 2.0 days. More patients of ATAIMH had hypertension than that of ATAAD (82.3% *vs.* 67.6%,  $P < 0.05$ ). Chest and back pain were the most common clinical symptoms. Computerized tomography (CT) was the most common initial diagnostic imaging modality. 84.7% received surgical treatment and in-hospital mortality was 5.3%. Patients with ATAAD mainly received surgical treatment (89.6%), while most patients with ATAIMH received medical treatment (39.2%) or endovascular repair (35.4%).

**Conclusions:** Our study suggests that doctors should comprehensively use clinical examination and genetic background screening for patients with ATAAD and ATAIMH and further shorten the time range from symptoms onset to intervention, achieving early diagnosis and treatment, thereby reducing the mortality rate of patients with aortic dissection in China. We should standardize the procedures of aortic dissection treatment and improve people's understanding. Meanwhile, the curing and transferring efficiency should also be improved.

**Keywords:** Aortic dissection; Acute type A aortic dissection; Acute type A intramural hematoma

## Introduction

Aortic dissection is a rare and life-threatening disease with high mortality, of which the diagnosis and treatment face great challenges. Acute aortic dissection (AAD) especially needs more attention. The International Registry of Acute Aortic Dissection (IRAD) was established in 1996, aiming to evaluate the clinical manifestations, management, and outcomes based on a large sample of patients in multiple centers, so as to improve the understanding of this difficult-

to-diagnose disease and provide new ideas for management.<sup>[1]</sup> In China, the incidence of aortic dissection is increasing, among which type A aortic dissection is one of the main types with a high disability and mortality rate. To better understand AAD in the Chinese population, the first Registry of Aortic Dissection in China (Sino-RAD) was established in 2011 which included 15 cardiovascular centers. The results of our previous study demonstrated that Chinese patients with AAD showed different

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characteristics from those in Western countries, such as the earlier onset of symptoms, lower proportion of hypertension, and differences in treatment strategies.<sup>[2]</sup> Although the symptoms and signs of type A aortic dissection have not changed significantly in the past decade, and Chinese clinicians have made considerable progress in the diagnosis and treatment of the disease, there is still a lack of a large sample study of clinical characteristics for type A aortic dissection in China.

Therefore, we evaluated the risk factors, clinical manifestations, management, and in-hospital outcomes of 1712 patients with acute type A aortic dissection (ATAAD) and acute type A intramural hematoma (ATAIMH) based on the Sino-RAD database. We expect this analysis will provide further insights into the clinical characteristics of patients with ATAAD and ATAIMH in China and promote a better understanding of the diseases.

## Methods

### Ethical approval

The experimental protocols were approved by the Institutional Ethics Board and every participant provided written informed consent.

### Patient selection

All patients with ATAAD and ATAIMH enrolled into Sino-RAD from January 1, 2012 to December 31, 2016 were analyzed. The institution and structure of Sino-RAD have been described previously.<sup>[2]</sup> Patients were identified prospectively or retrospectively through the retrieval of discharge diagnosis records, surgery, and echocardiography databases. The diagnosis was made based on history, physical examination, imaging studies, visualization at surgery, and/or autopsy results. Patients with aortic injury secondary to trauma were excluded.

### Data collection

The data were collected based on a standard questionnaire developed by Sino-RAD researchers, including demographic data, history, physical examination findings, imaging studies, management, and outcomes. The data were collected by physicians at presentation or retrospectively

and sent to the Sino-RAD Coordination Center of the Fourth Military Medical University.

### Statistical analysis

Categorical data are shown as frequency and percentage, while continuous variables were shown as mean  $\pm$  standard deviation (SD). The continuous variables were compared using the Student's *t* test for normal distributions and the Mann-Whitney *U* test for non-normal distributions. Categorical variables were compared using the chi-square test or Fisher exact test, as appropriate. The data were analyzed using SPSS 22.0 (IBM Corporation, Armonk, NY, USA). All *P* values are two-sided, and *P* < 0.05 was considered statistically significant.

## Results

### Demographic data

Overall, 1712 patients were enrolled in this study, of which 1582 patients were ATAAD and 130 patients were ATAIMH [Table 1]. The mean age of all patients was 48.4 years. Patients with ATAAD were significantly younger than patients with ATAIMH ( $48.9 \pm 11.1$  years *vs.*  $55.6 \pm 11.0$  years, *P* < 0.001). For the whole cohort, males are dominant, but the rate of male patients with ATAAD was significantly higher compared to that of patients with ATAIMH (78.3% *vs.* 68.5%, *P* = 0.01).

### Patient history

The time from the onset of symptom to hospitalization was 2.0 days (0.8–8.0) [Tables 2–4]. Marfan syndrome was present in 6.0% of all patients; however, none of Marfan syndrome was detected in ATAIMH patients. A history of hypertension was elicited in 68.7% of all patients. The proportion of hypertension was significantly higher in patients with ATAIMH than in patients with ATAAD (82.3% *vs.* 67.6%, *P* < 0.05). For the whole cohort, about 44.8% of hypertension patients did not receive any drugs and 38.9% had poor control with drugs. A history of cardiovascular surgery was present in 37 patients (2.2%), including 2 congenital heart diseases, 14 aortic surgery, 20 valve surgery, and 1 coronary artery bypass graft (CABG) surgery. The number of patients with a history of smoking

**Table 1: Demographic data of ATAAD and ATAIMH.**

Variables	Overall ( <i>n</i> = 1712)	ATAAD ( <i>n</i> = 1582)	ATAIMH ( <i>n</i> = 130)	<i>P</i>
Age (year)	48.4 $\pm$ 11.2	48.9 $\pm$ 11.1	55.6 $\pm$ 11.0	<0.001
$\geq$ 70	44 (2.6)	31 (2.0)	13 (10.0)	
60–69	295 (17.2)	264 (16.7)	31 (23.8)	
50–59	503 (29.4)	457 (28.9)	46 (35.4)	
40–49	568 (33.2)	538 (34.0)	30 (23.1)	
<40	302 (17.6)	292 (18.5)	10 (7.7)	
Male	1328 (77.6)	1239 (78.3)	89 (68.5)	0.01
Male/female	1328/384	1239/343	89/41	

Data presented as mean  $\pm$  SD, *n* or *n* (%). ATAAD: Acute type A aortic dissection; ATAIMH: acute type A intramural hematoma; SD: Standard deviation.

**Table 2: Patient history of ATAAD and ATAIMH.**

Variables	Overall (n = 1712)	ATAAD (n = 1582)	ATAIMH (n = 130)	P
Time from onset to hospitalization (days)	2.0 (0.8–8.0)	2.0 (0.8–9.0)	1.1 (1.0–4.0)	0.260
Marfan syndrome	102 (6.0)	102 (6.4)	0	0.003
Hypertension	1176 (68.7)	1069 (67.6)	107 (82.3)	<0.001
Without any drugs	527/1176 (44.8)	498/1069 (46.6)	29/107 (27.1)	<0.001
Poor control with drugs	457/1176 (38.9)	411/1069 (38.4)	46/107 (43.0)	0.360
Well control with drugs	192/1176 (16.3)	160/1069 (15.0)	32/107 (29.9)	<0.001
Prior aortic dissection	45/1710 (2.6)	41/1580 (2.6)	4 (3.1)	0.770
Prior cardiovascular surgery	37/1703 (2.2)	37/1574 (2.4)	0/129 (0)	0.110
Congenital heart disease surgery	2 (5.4)	2 (5.4)	0	
Aortic surgery	14 (37.8)	14 (37.8)	0	
Valve surgery	20 (54.1)	20 (54.1)	0	
CABG surgery	1 (2.7)	1 (2.7)	0	
Smoking	729 (42.6)	675 (42.7)	54 (41.5)	0.840
Drinking	268 (15.7)	248 (15.7)	20 (15.4)	0.930
Trauma	3	3	0 (0)	1.000
Traffic accident	3	3	0 (0)	1.000

Data presented as median (interquartile range) or n (%). ATAAD: Acute type A aortic dissection; ATAIMH: acute type A intramural hematoma; CABG: Coronary artery bypass grafting.

**Table 3: Time from onset to admission of ATAAD and ATAIMH.**

Variables	Total (n = 1712)	ATAAD (n = 1582)	ATAIMH (n = 130)	P
<8 h	140 (8.2)	135 (8.5)	5 (3.8)	0.049
8–24 h	594 (34.7)	534 (33.8)	60 (46.2)	0.004
24–48 h	215 (12.5)	193 (12.2)	22 (16.9)	0.118
>48 h	763 (44.6)	720 (45.5)	43 (33.1)	0.006

Data presented as n (%); ATAAD: Acute type A aortic dissection; ATAIMH: acute type A intramural hematoma.

**Table 4: Time from admission to operation of ATAAD and ATAIMH.**

Variables	Total (n = 1450)	ATAAD (n = 1417)	ATAIMH (n = 33)	P
<8 h	938 (64.7)	923 (65.1)	15 (45.5)	0.020
8–24 h	369 (25.4)	361 (25.5)	8 (24.2)	0.870
>24 h	143 (9.9)	133 (9.4)	10 (30.3)	0.001

Data presented as n (%); ATAAD: Acute type A aortic dissection; ATAIMH: acute type A intramural hematoma.

and drinking in the entire cohort was 729 (42.6%) and 268 (15.7%), respectively. Only 8.2% of patients were admitted into the hospital in <8 h, while about half (44.6%) of the patients admitted in >48 h. 64.7% of patients received surgical operation in <8 h from admission to operation.

**Presenting symptoms and physical examination**

Severe pain was the most common presenting symptom (92.3%) [Table 5]. The majority of patients complained of back pain (79.3%). About 30.2% of patients complained of chest pain. Some patients did not complain of any pain because they came unconsciously.

**Initial modality and electrocardiographic findings**

Computerized tomography (CT) was the most common initial diagnostic imaging modality to identify patients (92.8%) with ATAAD or ATAIMH [Table 6]. The results of electrocardio-

gram found that 44.2%, 1.4%, and 0.9% of patients had myocardial ischemia, myocardial infarction, and atrial fibrillation, respectively. And the incidence of myocardial ischemia in patients with ATAAD was significantly lower than in patients with ATAIMH (42.7% vs. 61.8%,  $P < 0.001$ ).

**In-hospital management and outcomes**

In the whole cohort, 1450 patients (84.7%) received surgical treatment, and the remaining patients received medical treatment, endovascular repair, and hybrid procedures [Table 7]. There is a significant difference in definitive management between ATAAD and ATAIMH groups ( $P < 0.001$ ). Among them, patients with ATAAD mainly received surgical treatment (89.6%), while most patients with ATAIMH received medical treatment (39.2%) or endovascular repair (35.4%). In-hospital survival of the whole cohort was 94.7%. And the mortality of patients with ATAAD and ATAIMH did not show statistical differences.

**Table 5: Presenting symptoms and physical examination of ATAAD and ATAIMH.**

Variables	Overall (n = 1712)	ATAAD (n = 1582)	ATAIMH (n = 130)	P
Presenting symptoms				
Any pain reported	1568/1698 (92.3)*	1448/1568 (92.3)*	120 (92.3)	0.99
Chest pain	473 (30.2)	458 (31.6)	15 (11.5)	
Back pain	1244 (79.3)	1133 (78.2)	111 (85.4)	
Abdominal pain	204 (13.0)	200 (13.8)	4 (3.1)	
Head and neck pain	35 (2.2)	35 (2.4)	0 (0)	
Limb pain	38 (2.4)	38 (2.6)	0 (0)	
Syncope	61 (3.6)	56 (3.5)	5 (3.8)	0.81
Congestive heart failure	6 (0.4)	5 (0.3)	1 (0.8)	0.38

Data presented as n (%). ATAAD: Acute type A aortic dissection; ATAIMH: acute type A intramural hematoma. \* Not all patients came to hospital consciously which would result in chief complaint missing.

**Table 6: Initial modality and electrocardiographic findings of ATAAD and ATAIMH.**

Variables	Overall (n = 1712)	ATAAD (n = 1582)	ATAIMH (n = 130)	P
Initial modality				
X-ray	3/1698 (0.2)	3/1569 (0.2)	0/129 (0)	1.000
Echocardiography	80/1698 (4.7)	76/1569 (4.8)	4/129 (3.1)	0.370
CT	1575/1698 (92.8)	1451/1569 (92.5)	124/129 (96.1)	0.130
MRI	9/1698 (0.5)	9/1569 (0.6)	0/129 (0)	1.000
Aortography	31/1698 (1.8)	30/1569 (1.9)	1/129 (0.8)	0.720
Electrocardiography				
No abnormalities	808/1512 (53.4)	761/1389 (54.8)	47/123 (38.2)	<0.001
Myocardial ischemia	669/1512 (44.2)	593/1389 (42.7)	76/123 (61.8)	<0.001
Myocardial infarction	21/1512 (1.4)	21/1389 (1.5)	0/123 (0)	0.410
Atrial fibrillation	14/1512 (0.9)	14/1389 (1.0)	0/123 (0)	0.620

Data presented as n (%). ATAAD: Acute type A aortic dissection; ATAIMH: acute type A intramural hematoma; CT: Computed tomography; MRI: Magnetic resonance imaging.

**Table 7: In-hospital management and outcomes of ATAAD and ATAIMH.**

Variables	Overall (n = 1712)	ATAAD (n = 1582)	ATAIMH (n = 130)	P
Definitive management				<0.001
Medical treatment	175 (10.2)	124 (7.8)	51 (39.2)	
Surgery	1450 (84.7)	1417 (89.6)	33 (25.4)	
Ascending aorta cannulation	146 (10.1)	141 (10.0)	5 (15.2)	0.370
Innominate aorta cannulation	69 (4.8)	68 (4.8)	1 (3.0)	1.000
Axillary aorta cannulation	983 (67.8)	965 (68.1)	18 (54.5)	0.090
Femoral aorta cannulation	815 (56.2)	797 (56.2)	18 (54.5)	0.850
Previous artificial blood vessel cannulation	48 (3.3)	47 (3.3)	1 (3.0)	1.000
Minimum nasopharyngeal temperature (°C)	20.8 ± 3.1	20.7 ± 3.1	22.4 ± 2.6	0.007
Minimum rectal temperature (°C)	23.0 ± 2.8	23.0 ± 2.8	23.7 ± 2.4	0.370
Bentall operation	623 (43.0)	611 (43.1)	12 (36.4)	0.440
Ascending aorta replacement	695 (47.9)	679 (47.9)	17 (51.5)	0.950
Semi-aortic arch replacement	81 (5.6)	80 (5.6)	1 (3.0)	1.000
Total aortic arch replacement	1125 (77.6)	1101 (77.7)	24 (72.7)	0.500
Elephant trunk stenting	1045 (72.1)	1063 (75.0)	21 (63.6)	0.190
Endovascular treatment	68 (4.7)	22 (1.6)	46 (35.4)	
Hybrid treatment	19 (1.3)	19 (1.3)	0 (0)	
In-hospital survival	1621 (94.7)	1495 (94.5)	126 (96.9)	0.240

Data presented as n (%) and mean ± SD. ATAAD: Acute type A aortic dissection; ATAIMH: acute type A intramural hematoma; SD: Standard deviation.

### Postoperation complications

In the entire cohort, 11.7% of patients had cardiovascular complications of which 6.5% of patients was hemorrhage [Table 8]. 22.7% of patients had respiratory complications

of which 12.1% of patients were pulmonary inflammation. 10.5% patients had neurological dysfunction including 2.5% temporary neurological dysfunction (TND) and 8.1% permanent neurological dysfunction (PND), and

**Table 8: Postoperation complications of ATAAD and ATAIMH.**

Variables	Total (n = 1712)	ATAAD (n = 1582)	ATAIMH (n = 130)	P
Cardiovascular complications	201 (11.7)	200 (12.6)	1 (0.8)	<0.001
Hemorrhage	112 (6.5)	111 (7.0)	1 (0.8)	0.006
Heart arrest	34 (2.0)	34 (2.1)	0	0.110
Cardiac tamponade	7 (0.4)	7 (0.4)	0	1.000
Lower cardiac output symptom	19 (1.1)	19 (1.2)	0	0.390
Malignant arrhythmia	29 (1.7)	29 (1.8)	0	0.160
Respiratory complications	389 (22.7)	385 (24.3)	4 (3.1)	<0.001
Acute respiratory insufficiency	96 (5.6)	96 (6.1)	0	0.004
Pulmonary inflammation	207 (12.1)	203 (12.8)	4 (3.1)	0.001
Pleural effusion	86 (5.0)	85 (5.4)	1 (0.8)	0.020
Neurologic dysfunction	180 (10.5)	179 (11.3)	1 (0.8)	<0.001
Temporary	42 (2.5)	41 (2.6)	1 (0.8)	0.370
Permanent	138 (8.1)	138 (8.7)	0	<0.001
Renal insufficiency	205 (12.0)	203 (12.8)	2 (1.5)	<0.001
Dialysis	114 (6.7)	114 (7.2)	0	0.002
Without dialysis	91 (5.3)	89 (5.6)	2 (1.5)	0.046
Hepatic insufficiency	107 (6.3)	106 (6.7)	1 (0.8)	0.010
Digestive complications	35 (2.0)	35 (2.2)	0	0.110
Secondary thoracotomy	45 (2.6)	45 (2.8)	0	0.045

Data presented as *n* (%). ATAAD: Acute type A aortic dissection; ATAIMH: acute type A intramural hematoma.

12.0% patients had renal insufficiency of which 6.7% patients received dialysis. The ATAAD patients had more cardiovascular complications, respiratory complications, neurologic dysfunction, and renal insufficiency than that of ATAIMH.

## Discussion

ATAAD and ATAIMH are life-threatening conditions associated with high mortality due to potentially fatal complications that require timely emergency operations. If untreated, ATAAD has a mortality of 33% within the first 24 h and rises to 50% by the first 48 h.<sup>[3]</sup> Despite the continuous improvement in diagnostic techniques and management strategies, mortality is very high, which may be related to the complex clinical features of the diseases.<sup>[4]</sup> As a global database, the IRAD which was established in 1996 has made great contributions to understand and improve the prognosis of the diseases for clinicians.<sup>[5]</sup> Another representative international database of AAD is the German Registry for Acute Aortic Dissection Type A (GERAADA). However, most patients included in IRAD or GERAADA are from developed countries which could not reflect the actual situation of AD in China. In 2011, the establishment of Sino-RAD was led by the Department of Cardiovascular Surgery, Xijing Hospital of the Fourth Military Medical University. Through the study based on Sino-RAD, we can more specifically assess the epidemiological characteristics, risk factors, and clinical outcomes of AD in China. Meanwhile, the establishment of Sino-RAD can provide a basis to develop solutions to prevent and treat AD according to the Chinese actual situation and lay a foundation for better clinical research and promotion of new technologies related to AAD. However, there is still a lack of study on ATAAD and ATAIMH in China. Thus, we analyzed the clinical features of ATAAD and ATAIMH

in China based on the Sino-RAD database. As a result, we found that Chinese patients with ATAAD and ATAIMH showed the following properties.

The surgical operation treatment is still a first-selected way to treat ATAAD and ATAIMH patients. The purpose of surgery is to prevent rupture (which would result in the patient's death), to re-establish anatomical flow in potentially ischemic areas (when there is a threat of ischemia in any territory, surgery is essential in both proximal and distal dissection), and to correct any aortic regurgitation. This means that in ATAAD patients, the indication is usually for immediate surgery, to save the patient's life rather than to cure the disease. However, it should also be borne in mind that in the great majority of cases diagnosis takes place in hospitals or health centers with no direct access to surgery. It will take some time for the patients to get to the hospital (the time ranges from a few hours to some days) that has the ability to conduct the operation. The aim before operation is to minimize the risk of the dissection spreading or the aorta rupturing by controlling the determining factors of hypertension and left ventricular ejection wave amplitude ( $dp/dt$  max). Even so, surgery may be contraindicated (or at least not indicated) in cases of very advanced age (patients aged over 80 and in very poor health), associated severe and incurable or terminal disease, or profound neurological damage related to the dissection. However, from our study, we found out only 140 out of 1712 went to the cardiovascular center in 8 h. Total of 763 out of 1712 were admitted after 48 h. It means that there may exist many patients that have the rupture of AD. The reasons may lie in the weak public health network. The more time wasted before hospitalization, the more patients will die.

Hypertension is one of the independent risk factors for aortic dissection.<sup>[6]</sup> It is considered to be associated with

AAD, and a history of hypertension may be the most common predisposing factor for AAD. However, our previous study found that the incidence in Sino-RAD was significantly lower than that in IRAD (51.4% vs. 67.0%), and this phenomenon might be related to underreporting. The incidence of hypertension in patients with ATAAD was 67.6% in this larger sample size study. The change in detection rate of hypertension indicates that health awareness and routine physical examinations are gradually improving in China. Moreover, the incidence of hypertension in the ATAIMH group was significantly higher than that in the ATAAD group, which supports the view that blood pressure control is also critical for the presenting ATAIMH.<sup>[7]</sup> The number of hypertensive patients in China has reached 245 million. The results of our study suggest that blood pressure monitoring and ultrasound screening should be used for these patients to achieve early detection and intervention. On the other hand, poor control of blood pressure in ATAAD and ATAIMH patients with hypertension will result in the progress of the disease, even rupture of the dissection. For the prevention and treatment of AD in China, to improve people's knowledge of hypertension and standardize the drug treatment in patients' hypertension is necessary.

Marfan syndrome, an autosomal-dominant disorder with variable penetrance based on fibrillin-1 gene mutation, is an important causative factor for ATAAD in younger patients.<sup>[8,9]</sup> Notably, the data from Sino-RAD and IRAD showed that the incidence of Marfan syndrome in ATAAD patients was 6.4% and 4.5%, respectively, which reminds us that genetic background interpretation may be essential for these patients in China. De Beaufort *et al*<sup>[10]</sup> found that an estimated 5-year survival rate of 80.1% and an estimated re-intervention rate of 55.3% in patients with Marfan syndrome. Such a high rate of re-interventions highlights the need for careful surveillance and treatment for patients with Marfan syndrome surviving the acute phase of aortic dissection. In addition, the incidence of Marfan syndrome in the ATAIMH group was 0, and Matsushita *et al*<sup>[11]</sup> support our results. Further clinical and genetic analyses are necessary for this phenomenon. Since aortic dissection occurs on average 20 years earlier in patients with MFS compared with peers without MFS, ongoing postoperative follow-up and timely, well-planned re-interventions when needed are essential to achieve better life expectancy. The younger onset of AD in Marfan Syndrome reminds us that we should pay more attention to diagnosis and screening of pathogenic genes and more efforts should be made.

Most patients with ATAAD and ATAIMH had multiple imaging studies performed. CT is widely used as the imaging modality of the first choice for the assessment of AD and IMH and can be used even in clinically unstable patients, which was consistent with results of the IRAD.<sup>[12]</sup> For high-risk populations suspected of suffering from AD, such as patients with hypertension and Marfan syndrome, CT should be used to determine the morphological changes of the aorta under the premise of not exceeding the radiation dose. CT is also the first recommended check for patients who come to the hospital with symptoms onset.

Low incidence of chest pain and a high incidence of back pain exists in Sino-RAD. In China, the most common symptom at the presentation of ATAAD and ATAIMH is a sudden onset of severe back pain rather than chest pain. However, in IRAD, the most common presenting symptom was the abrupt onset of pain described as "severe" or the "worst ever" (93%), sharp (64.4%), and frequently localized to the chest (83%).<sup>[13]</sup>

The patients with ATAAD and ATAIMH showed no significant difference in symptoms, physical, and imaging examinations. However, there are differences in management. For ATAAD, surgery is still the main choice (89.6%), which is similar to the results of IRAD.<sup>[13]</sup> In fact, the rate of emergency surgery for aortic dissection in China has increased significantly in the past decades. Our data demonstrated that the median time from the onset of symptoms to hospitalization for patients with ATAAD is only 2 days, and many large-scale cardiovascular centers have established the *Green Channel* from the emergency room to the operation room, which further improved the prognosis of patients with ATAAD in China. However, most of the patients in the ATAIMH group received medical treatment (39.2%), which was supported by some studies in Eastern countries. They thought that ATAIMH is a relatively benign pathological process and therefore conservative treatments are more recommended.<sup>[14-16]</sup> However, it is recommended that ATAIMH should be treated identically to ATAAD in most Western institutions.<sup>[17,18]</sup> There is a difference in the choice of therapeutic strategies between Sino-RAD and IRAD. At the same time, in Sino-RAD endovascular treatment was performed for the ATAAD patients with rupture located distal to the left subclavian artery involving the ascending aorta retrogradely. According to the report by IRAD in 2004, there was no ATAAD patient who received endovascular treatment.<sup>[2]</sup>

Both TND and PND are the major neurological complications associated with surgical repair.<sup>[19]</sup> In our study, 138 (8.7%) patients with ATAAD had PND postoperatively among 1582 patients. The overall incidence of reported postoperative neurologic injury ranges from 2.9% up to 34.2% and varies from peripheral neuropathy to stroke or spinal cord injury and stroke appears to be the most common perioperative neurologic deficits.<sup>[20,21]</sup> In addition to procedure-related risk factors, negative neurological outcomes are often related to the preoperative condition of cerebral mal-perfusion of the patient,<sup>[22-24]</sup> which suggests that the monitoring and maintenance of cerebral perfusion are of great significance to the prognosis of ATAAD.

Finally, the choice of optimal surgical approach depends on the range of the dissection, especially the extent of the distal aortic repair. From Sino-RAD, total aortic arch replacement with elephant trunk stenting is the most used. There is a significant difference in in-hospital mortality between Sino-RAD and IRAD. Sino-RAD data demonstrated a significantly higher in-hospital survival rate, which is consistent with our previous study.<sup>[2]</sup> The possible explanation is selection bias because Sino-RAD mainly included large-scale cardiovascular centers and medical

resources are unevenly distributed in different areas. In addition, patients who died at the transferring facility and in the emergency room are not included in Sino-RAD. The in-hospital mortality between the ATAAD and ATAIMH groups showed no significant difference, which is supported by some studies.<sup>[25,26]</sup>

However, the study still has some limitations. First, there are many potentially high-risk patients who are not reflected in Sino-RAD, such as those with hypertension and Marfan syndrome, due to the limitations of economic level, health awareness, and testing tools. Second, since autopsy has not been widely promoted in China, many patients who died of AD were not included in this study, which may also contribute to the higher survival rate presented in the results. Finally, because of the short period since the establishment of Sino-RAD, there is not enough follow-up data to analyze the long-term survival rate of patients undergoing different treatments.

In conclusion, based on the Sino-RAD database, we analyzed the clinical profile and outcomes of ATAAD and ATAIMH from January 2012 to December 2016. The retrospective study suggests that doctors should comprehensively use clinical examination and genetic background screening for patients with ATAAD and ATAIMH and further shorten the time from symptoms onset to intervention, achieving early diagnosis and treatment, thereby reducing the mortality rate of AD patients in China. We should standardize procedures of AD treatment and improve people's understanding. Meanwhile, the curing and transferring efficiency should also be improved.

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### Conflicts of interest

None.

### References

1. Evangelista A, Isselbacher EM, Bossone E, Gleason TG, Eusanio MD, Sechtem U, *et al.* Insights from the International registry of acute aortic dissection: a 20-year experience of collaborative clinical research. *Circulation* 2018;137:1846–1860. doi: 10.1161/CIRCULATIONAHA.117.031264.
2. Wang W, Duan W, Xue Y, Wang L, Liu J, Yu S, *et al.* Clinical features of acute aortic dissection from the Registry of aortic dissection in China. *J Thorac Cardiovasc Surg* 2014;148:2995–3000. doi: 10.1016/j.jtcvs.2014.07.068.
3. LeMaire SA, Russell L. Epidemiology of thoracic aortic dissection. *Nat Rev Cardiol* 2011;8:103–113. doi: 10.1038/nrcardio.2010.187.
4. Berretta P, Trimarchi S, Patel HJ, Gleason TG, Eagle KA, Di Eusanio M. Malperfusion syndromes in type A aortic dissection: what we have learned from IRAD. *J Vis Surg* 2018;4:65. doi: 10.21037/jovs.2018.03.13.
5. Yuan X, Mitsis A, Tang Y, Nienaber CA. The IRAD and beyond: what have we unravelled so far? *Gen Thorac Cardiovasc Surg* 2019;67:146–153. doi: 10.1007/s11748-017-0817-6l.
6. Goldfinger JZ, Halperin JL, Marin ML, Stewart AS, Eagle KA, Fuster V. Thoracic aortic aneurysm and dissection. *J Am Coll Cardiol* 2014;64:1725–1739. doi: 10.1016/j.jacc.2014.08.025.
7. Brown JA, Arnaoutakis GJ, Kilic A, Gleason TG, Aranda-Michel E, Sultan I. Current trends in the management of acute type A aortic intramural hematoma. *J Card Surg* 2020;35:2331–2337. doi: 10.1111/jocs.14819.
8. Silverman DI, Burton KJ, Gray J, Bosner MS, Kouchoukos NT, Roman MJ, *et al.* Life expectancy in the Marfan syndrome. *Am J Cardiol* 1995;75:157–160. doi: 10.1016/S0002-9149(00)80066-1.
9. Gott VL, Greene PS, Alejo DE, Cameron DE, Naftel DC, Miller DC, *et al.* Replacement of the aortic root in patients with Marfan's syndrome. *N Engl J Med* 1999;340:1307–1313. doi: 10.1056/NEJM199904293401702.
10. de Beaufort HWL, Trimarchi S, Korach A, Di Eusanio M, Gilon D, Montgomery DG, *et al.* Aortic dissection in patients with Marfan syndrome based on the IRAD data. *Ann Cardiothorac Surg* 2017;6:633–641. doi: 10.21037/acs.2017.10.03.
11. Matsushita A, Fukui T, Tabata M, Sato Y, Takanashi S. Preoperative characteristics and surgical outcomes of acute intramural hematoma involving the ascending aorta: A propensity score-matched analysis. *J Thorac Cardiovasc Surg* 2016;151:351–358. doi: 10.1016/j.jtcvs.2015.09.055.
12. Hagan PG, Nienaber CA, Isselbacher EM, Bruckman D, Karavite DJ, Russman PL, *et al.* The International Registry of Acute Aortic Dissection (IRAD): new insights into an old disease. *JAMA* 2000;283:897–903. doi: 10.1001/jama.283.7.897.
13. Pape LA, Awais M, Woznicki EM, Suzuki T, Trimarchi S, Evangelista A, *et al.* Presentation, diagnosis, and outcomes of acute aortic dissection: 17-Year trends from the International Registry of Acute Aortic Dissection. *J Am Coll Cardiol* 2015;66:350–358. doi: 10.1016/j.jacc.2015.05.029.
14. Song J-K, Kim H-S, Song J-M, Kang D-H, Ha J-W, Rim S-J, *et al.* Outcomes of medically treated patients with aortic intramural hematoma. *Am J Med* 2002;113:181–187. doi: 10.1016/S0002-9343(02)01171-3.
15. Kitai T, Kaji S, Yamamuro A, Tani T, Tamita K, Kinoshita M, *et al.* Clinical outcomes of medical therapy and timely operation in initially diagnosed type a aortic intramural hematoma: a 20-year experience. *Circulation* 2009;120 (11 Suppl):S292–S298. doi: 10.1161/CIRCULATIONAHA.108.843615.
16. Kaji S, Akasaka T, Horibata Y, Nishigami K, Shono H, Katayama M, *et al.* Long-term prognosis of patients with type a aortic intramural hematoma. *Circulation* 2002;106 (12 Suppl 1):I248–I252. doi: 10.1016/S1062-1458(02)01001-2.
17. Hiratzka LF, Bakris GL, Beckman JA, Bersin RM, Carr VF, Casey DE, *et al.* 2010 ACCF/AHA/AAATS/ACR/ASA/SCA/SCAI/SIR/STS/SVM Guidelines for the diagnosis and management of patients with

- thoracic aortic disease. A Report of the American College of Cardiology Foundation/American Heart Association Task Force on Practice Guidelines, American Association for Thoracic Surgery, American College of Radiology, American Stroke Association, Society of Cardiovascular Anesthesiologists, Society for Cardiovascular Angiography and Interventions, Society of Interventional Radiology, Society of Thoracic Surgeons, and Society for Vascular Medicine. *J Am Coll Cardiol* 2010;55:e27–e129. doi: 10.1213/ANE.0b013e3181dd869b.
18. Erbel R, Aboyans V, Boileau C, Bossone E, Bartolomeo RD, Eggebrecht H, *et al*. 2014 ESC guidelines on the diagnosis and treatment of aortic diseases: Document covering acute and chronic aortic diseases of the thoracic and abdominal aorta of the adult. The task force for the diagnosis and treatment of aortic diseases of the European Society of Cardiology (ESC). *Eur Heart J* 2014;35:2873–2926. doi: 10.1093/eurheartj/ehu281.
  19. Ehrlich MP, Schillinger M, Grabenwöger M, Kocher A, Tschernko EM, Simon P, *et al*. Predictors of adverse outcome and transient neurological dysfunction following surgical treatment of acute type A dissections. *Circulation* 2003;108 (Suppl 1):II318–II323. doi: 10.1161/01.cir.0000087428.63818.50.
  20. Tsagakis K, Konorza T, Dohle DS, Kottenberg E, Buck T, Thielmann M, *et al*. Hybrid operating room concept for combined diagnostics, intervention and surgery in acute type A dissection. *Eur J Cardiothorac Surg* 2013;43:397–404. doi: 10.1093/ejcts/ezs287.
  21. Buonocore M, Amarelli C, Scardone M, Caiazza A, Petrone G, Majello L, *et al*. Cerebral perfusion issues in acute type A aortic dissection without preoperative malperfusion: how do surgical factors affect outcomes? *Eur J Cardiothorac Surg* 2016;50:652–659. doi: 10.1093/ejcts/ezw152.
  22. Girdauskas E, Kuntze T, Borger MA, Falk V, Mohr F-W. Surgical risk of preoperative malperfusion in acute type A aortic dissection. *J Thorac Cardiovasc Surg* 2009;138:1363–1369. doi: 10.1016/j.jtcvs.2009.04.059.
  23. Chiappini B, Schepens M, Tan E, Dell Amore A, Morshuis W, *et al*. Early and late outcomes of acute type A aortic dissection: analysis of risk factors in 487 consecutive patients. *Eur Heart J* 2005;26:180–186. doi: 10.1016/j.accreview.2005.04.038.
  24. Trimarchi S, Nienaber CA, Rampoldi V, Myrmet T, Suzuke T, Mehta RH, *et al*. Contemporary results of surgery in acute type A aortic dissection: The International registry of acute aortic dissection experience. *J Thorac Cardiovasc Surg* 2005;129:112–122. doi: 10.1016/j.accreview.2005.04.039.
  25. Harris KM, Braverman AC, Eagle KA, Woznicki EM, Pyeritz RE, Myrmet T, *et al*. Acute aortic intramural hematoma: An analysis from the International Registry of Acute Aortic Dissection. *Circulation* 2012;126 (11 Suppl 1):S91–S96. doi: 10.1161/CIRCULATIONAHA.111.084541.
  26. Evangelista A, Mukherjee D, Mehta RH, O’Gara PT, Fattori R, Cooper JV, *et al*. Acute intramural hematoma of the aorta: a mystery in evolution. *Circulation* 2005;111:1063–1070. doi: 10.1161/01.CIR.0000156444.26393.80.

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