Journal of Cardiothoracic Surgery

RESEARCH

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Chronobiological variations of acute aortic dissection in a Northwest Chinese population

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Abstract

Background The prevalence of acute aortic dissection (AAD) has been gradually increasing in recent years. This study aimed to investigate the circadian variations of AAD onset in a northwest Chinese population and provide scientific insights for AAD prevention.

Methods The clinical data of 1,145 AAD patients admitted to our hospital between January 2010 and December 2020 were retrospectively collected, and the periodic features of AAD were analyzed.

Results Stanford type A and type B AAD were present in 58.43% (669 cases) and 41.57% (476 cases) of the patients, respectively. The incidence rate was highest in the winter (358 cases, 31.27%) and lowest in the summer (225 cases, 19.65%). AAD occurred at the highest rate between 19:00–24:00 (321 cases, 28.03%) and the lowest rate between 1:00–6:00 (247 cases, 21.57%). Stanford type A AAD was most prevalent in the winter and the least prevalent in the spring, whereas Stanford type B AAD was most prevalent in the winter and the least prevalent in the summer. The difference between type A and type B in seasonal distribution was significant in spring ($\chi^2 = 17.666$, $P < 0.001$) and summer ($\chi^2 = 6.228$, $P = 0.013$). Stanford type A cases appeared most during 19:00–24:00 (236 cases, 35.28%) and least during 13:00–18:00 (73 cases, 10.91%), while Stanford type B cases appeared most during 13:00–18:00 (239 cases, 50.21%) and least during 1:00–6:00 (60 cases, 12.61%). The difference between type A and type B in period distribution was significant in all periods of time.

Conclusions AAD onset followed a chronobiological pattern in patients from northwest China, with winter and 19:00–24:00 being the peak season and time period of AAD occurrence, respectively.

Keywords Acute aortic dissection, Chronobiological patterns, Northwest China, Incidence rate

Background

Acute aortic dissection (AAD) is a life-threatening condition manifested by a primary tear in the aortic intima or rupture of the vasa vasorum. The prevalence of AAD has been gradually increasing in recent years [1]. Mortality associated with AAD is approximately 1–2% per hour after the appearance of symptoms, such as severe chest, back pain, and hypotension [2]. Without treatment, a majority of patients die from cardiac tamponade or arrhythmia. Thus, a thorough understanding of the features of the disease would help determine which applicable prevention measure is of particular importance.

Chronobiological patterns (circadian, weekly, and seasonal/monthly) are among the adaptations the human body undergoes in response to the external environment. These patterns have been demonstrated in multiple cardiovascular diseases [3] including coronary heart disease [4], acute myocardial infarction [5], arrhythmia

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[6], stroke [7], and heart failure [8]. It is well known that most adverse cardiovascular cases arise in the winter and early morning, especially within the first three hours after waking up. A previous study revealed a significantly higher incidence of AAD in the morning from 8:00–10:00 and a lower incidence from 0:00–2:00 [9]. Similarly, AAD occurs more frequently in winter, especially in the month of January. Several studies that investigated the chronobiological properties of AAD in patients in northern and central China reported that winter (December) was the peak season and summer (June) was the trough season for AAD regardless of sex, age and type of AAD [10, 11]. Patients in the northern Chinese region tended to suffer from AAD attacks during 13:00–18:00, while patients in central China had more AAD attacks during 9:00–10:00 and 16:00–17:00.

China stretches across cold, temperate, and tropical zones, spanning five time zones from east to west. The chronobiological patterns of AAD likely vary among these different territories. The present study was designed to retrospectively analyze the clinical data of 1,145 AAD patients admitted to the People's Hospital of Xinjiang Uygur Autonomous Region from January 2010 to December 2020. The relationships between onset of different types of AAD and time of day, seasons, demographic traits, and medical history were evaluated. The purpose of this study was to clarify the periodic characteristics of AAD onset in patients from northwest China and provide scientific insights for the prevention of AAD.

Methods

The clinical data of 1,145 AAD patients admitted to the People's Hospital of Xinjiang Uygur Autonomous Region were collected from January 1, 2010 to December 31, 2020, including 669 patients with Stanford type A and 476 patients with Stanford type B AAD.

AAD onset time was divided into four seasons (spring: March to May; summer: June to August; autumn: September to November; and winter: December to February) and four time periods (1:00–6:00, 7:00–12:00, 13:00–18:00, and 19:00–24:00). Associations between multiple factors including clinical type, age, gender, and history of hypertension and AAD onset time were evaluated. According to The European Society of Cardiology (ESC) guidelines, AD was classified into three phases: AAD (defined as <14 days after symptom presentation), subacute AD (15–90 days), and chronic AD (>90 days) [12].

The clinical data were analyzed using SPSS 23.0. Measurement data are presented as mean±standard deviation (SD), and counting data are shown as the composition ratio. Comparisons of counting data between groups were determined using the χ^2 test or Fisher's exact test. A *P*-value of <0.05 was considered statistically significant.

Results

Clinical data of patients

The basic characteristics of involved patients are shown in Table 1. A total of 1,145 patients (669 with Stanford type A and 476 with Stanford type B AAD) were included in this study. The mean age was 52.51±11.47 years with 335 patients (29.26%) under 45 years of age. There were 596 (52.05%) male patients. Furthermore, a history of

Table 1 Basic characteristics of participants according to AAD type

Variables	All	AAD type	
		A	B
Number	1145	669	476
Age, *n (%)*			
<45 year	335(29.26)	198(29.60)	137(28.78)
45–59 year	347(30.31)	281(42.00)	66(13.87)
≥60 year	463(40.43)	190(28.40)	273(57.35)
Male, *n (%)*	596(52.05)	237(35.43)	359(75.42)
Hypertension, *n (%)*	619(54.06)	357(53.36)	262(55.04)
Season, **n*(%)***			
spring	270 (23.58)	128(19.13)	142(29.83)
summer	225(19.65)	148(22.12)	77(16.18)
autumn	292(25.50)	178(26.61)	114(23.95)
winter	358(31.27)	215(32.14)	143(30.04)
Periods, *n (%)*			
1:00–6:00	247(21.57)	187(27.95)	60(12.61)
7:00–12:00	265 (23.14)	173(25.86)	92(19.33)
13:00–18:00	312(27.25)	73(10.91)	239(50.21)
19:00–24:00	321 (28.03)	236(35.28)	85(17.86)

hypertension was present in 619 (54.06%) patients. Age and gender were significantly different in patients with different types of AAD ($P<0.001$).

Characteristics of AAD in different seasons

The season distribution of AAD cases is shown in Table 2. In total, 270 (23.58%) AAD cases occurred in spring, 225 (19.65%) in summer, 292 (25.50%) in autumn, and 358 (31.27%) in winter. Stanford type A AAD showed the highest incidence in winter and the lowest incidence in spring, whereas Stanford type B had the highest incidence in winter and the lowest incidence in summer. The difference between type A and type B AAD in seasonal distribution was significant in spring ($\chi^2=17.666$, $P<0.001$) and summer ($\chi^2=6.228$, $P=0.013$). There was also a gender difference in spring ($\chi^2=4.64$, $P=0.031$) and autumn ($\chi^2=4.576$, $P=0.032$).

Characteristics of AAD in different time periods

The time distribution of AAD cases is shown in Table 3. We found the following distributions in the AAD cases: 247 (21.57%) during 1:00–6:00; 265 (23.14%) during 7:00–12:00; 312 (27.25%) during 13:00–18:00; and 321 (28.03%) during 19:00–24:00.

Stanford type A AAD occurred the most during 19:00–24:00 (236 cases, 35.28%) and the least during 13:00–18:00 (73 cases, 10.91%). Stanford type B AAD occurred the most during 13:00–18:00 (239 cases, 50.21%) and the least during 1:00–6:00 (60 cases, 12.61%). The difference between type A and type B AAD in period distribution was significant in all periods of time. Furthermore, the age associated distribution of AAD showed a significant difference during 13:00–18:00 ($\chi^2=10.307$, $P=0.006$) and 19:00–24:00 ($\chi^2=9.837$, $P=0.007$), with the highest incidence present in the elderly group. But there was no statistically significant difference in gender and hypertension.

Discussion

The present study showed that the incidence rate of AAD (both type A and type B AAD) was the highest in the winter and lowest in the summer, which is consistent with patterns reported for other cardiovascular events [13, 14]. Previous studies also indicated a strong influence of chronobiological rhythm on the occurrence of AAD [10]. Vitale et al. [15] analyzed more than 80,000 patients in a meta-analysis and found a significantly higher incidence of AAD in the winter. Similarly, Ma et al. [16] examined 1,642 AAD patients from two aortic referral centers in the United States and China, and reported that the peak season for AAD onset was the winter. Mehta et al. [17] found a similar trend and suggested that the relative temperature, rather than absolute temperature, and/or endogenous annual rhythms were critical mechanistic

Table 2 The effect of covariates on season in AAD patients

Season	spring				summer				autumn				winter			
	Yes	No	χ^2	*P*	Yes	No	χ^2	*P*	Yes	No	χ^2	*P*	Yes	No	χ^2	*P*
Number	270	875			225	920			292	853			358	787		
Age, *n* (%)			0.392	0.822			3.989	0.136			3.423	0.181			3.447	0.178
< 45 year	82	253			78	257			81	254			94	241		
45–59 year	78	269			62	285			101	246			106	241		
≥ 60 year	110	353			85	378			110	353			158	305		
Male, *n* (%)	156	440	4.64	0.031	108	488	2.243	0.134	146	488	4.576	0.032	186	410	0.002	0.965
AAD type, n(%)			17.666	<0.001	225	920	6.228	0.013	292	853	1.034	0.309	358	787	0.568	0.451
A	128	541			148	521			178	491			215	454		
B	142	334			77	399			114	362			143	333		
Hypertension, *n* (%)	146	473	<0.001	0.996	121	498	0.009	0.924	153	466	0.437	0.509	199	420	0.488	0.485

Yes or no refers to spring or not spring (all other seasons)

factors in AAD onset. Geographically, northwest China is located in the middle temperate zone, which is cold in the winter and hot in the summer. The temperature difference between day and night is relatively large, which may be an underlying pathophysiological mechanism behind the onset of AAD. Furthermore, we found that the differences in the seasonal distributions of types A and B were significant in spring and summer. Type B AAD has been reported [11] to have a higher incidence in spring than type A AAD does, which is consistent with our study. However, both type A AAD and type B AAD had the lowest prevalence in summer, which conflicts with our study. The reason might be that the study was a single-center retrospective study, and there may be bias in the collection of data from the medical records system.

We also found a peak time of AAD onset during 19:00–24:00 and a trough during 1:00–6:00. The circadian pattern of AAD has been reported previously. Takagi [9] found a pattern of high incidence of AAD during 8:00–10:00 and low incidence during 0:00–2:00 in a meta-analysis enrolling 1,827 patients with AAD. The circadian rhythm of blood pressure may play a role in the underlying AAD pathophysiology. Furthermore, according to the clinical classification, the highest incidence of Stanford type A AAD was from 19:00–24:00 and the lowest was from 13:00–18:00. However, the Stanford type B AAD had the highest incidence from 13:00–18:00 and the lowest incidence from 1:00–6:00. The onset rhythm of type B AAD in the present study is consistent with recent studies [10], but the onset rhythm of type A AAD was different. Zhang Liang [10] found that the incidence of type A AAD was higher at 13:00–18:00 and 19:00–24:00 and lowest at 1:00–6:00. People in China tend to consume strong alcohol and salty foods in the afternoon, which may contribute to elevated blood pressure and the higher afternoon peak of AAD. This difference in different types of AAD might be because type A AAD is more invasive than type B AAD is, and some patients may die before hospitalization due to rupture of the entrapment, leading to inevitable loss of data.

Due to external stimulations and changes in physical and mental activities, blood pressure fluctuates greatly in the day and drops by 10%~20% during sleep, so the incidence rate of nocturnal disease may be low when blood pressure is relatively stable at night [18]. The middle-aged group in this study had a more concentrated incidence distribution, which may be related to changes in lifestyle and daily schedule. Being male has been considered an important risk factor for AAD, with an AAD incidence of 6.9/100,000, while being female is associated with an incidence of 2.9/100,000 [19], similar to the finding of this study.

In our study, hypertension was prevalent in AAD patients. The incidence of hypertension is high in northwest China, with it being higher in Xinjiang than in the general Chinese population. Recently, it has been reported that 35.01% of adults aged ≥ 35 years and 40.7% of adults aged ≥ 45 years suffer from hypertension in Xinjiang province [20]. Hypertension is closely related to diet, living habits, mental state, physical activity, geographical environment, age, obesity, diabetes, dyslipidemia, and genetic background. Xinjiang has specific cultures, social, and dietary habits, such as the over-consumption of liquor and salty foods. These factors might account for the high incidence of hypertension in the region. Therefore, it is necessary to understand what factors contribute to AAD risk and to improve preventative measures, such as taking anti-hypertension drugs in the evening to accommodate daily physiological oscillations [21]. Our findings provide novel insights about the utility of learning seasonal and circadian patterns of AAD in northwest China.

Conclusions

Although we found that the onset time of AAD exhibited climatic characteristics, it is important to note the limitations of our study. This was a single-center retrospective analysis, and any interpretations regarding AAD should be made with caution due to the limited number of patients and the fact that some patients did not receive timely treatment. In the future, the relationship between AAD occurrence and climate in Xinjiang could be elucidated through a multi-center study with a larger sample.

Table 3 The effect of covariates on period in AAD patients

Period	1:00–6:00				7:00–12:00				13:00–18:00				19:00–24:00			
	Yes	**No**	**χ^2**	***P***	**Yes**	**No**	**χ^2**	***P***	**Yes**	**No**	**χ^2**	***P***	**Yes**	**No**	**χ^2**	***P***
Number	247	898			265	880			312	833			321	824		
Age, *n* (%)			5.055	0.08			1.449	0.485			10.307	0.006			9.837	0.007
< 45 year	64	271			85	250			113	222			73	262		
45–59 year	89	258			75	272			82	265			101	246		
≥ 60 year	94	369			105	358			117	346			147	316		
Male, *n* (%)	123	473	0.642	0.423	145	451	0.981	0.322	167	429	0.373	0.541	161	435	0.643	0.423
AAD type, n(%)			38.719	<0.001			6.671	0.01			216.664	<0.001			41.828	<0.001
A	187	482			173	496			73	596			236	433		
B	60	416			92	384			239	237			85	391		
Hypertension, *n* (%)	129	490	0.427	0.514	146	473	0.550	0.458	171	448	0.096	0.756	173	446	0.005	0.944

Yes or no refers to 1:00–6:00 or not 1:00–6:00 (all other times)

Abbreviations

AAD Acute aortic dissection

Acknowledgements

Not applicable.

Author contributions

ET and RI analyzed and interpreted the patient data regarding the hematological disease and the transplant. DC performed data curation. AN contributed to the formal analysis. YG was a major contributor in writing the manuscript. All authors read and approved the final manuscript.

Funding

None.

Data availability

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

The study received approval from the Ethics Committee of the Institute of Biomedicine, People's Hospital of Xinjiang Uygur Autonomous Region, and was consistent with the Declaration of Helsinki. All patients participating in this study provided their written informed consent.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

Received: 2 February 2024 / Accepted: 1 December 2024

Published online: 20 December 2024

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