Heart and Vessels (2019) 34:1748–1757
https://doi.org/10.1007/s00380-019-01419-9

ORIGINAL ARTICLE

Is systolic blood pressure high in patients with acute aortic dissection on first medical contact before hospital transfer?

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Received: 30 November 2018 / Accepted: 26 April 2019 / Published online: 6 May 2019

Abstract
Acute aortic dissection (AAD) cases are thought to have high blood pressure (BP) on admission; however, little data are available on BP prior to admission. The purpose of this study was to investigate systolic blood pressure (SBP) very early after symptom onset and before hospital transfer in patients with AAD to determine whether SBPs were high, and also whether SBPs were higher or lower compared with SBPs at hospital admission. We obtained results using three-year data derived from the Tokyo Acute Aortic Super Network Database. First, we selected 830 patients with AAD for which the "duration from symptom onset to first medical contact by ambulance crews" (SO-FMC) was within 60 min. We examined the SBPs of such patients. Next, we selected 222 patients with AAD whose SBPs were measured both at FMC, within 15 min after symptom onset, and at hospital admission, and compared SBPs at FMC with those at hospital admission. Among types A ($n=190$) and B ($n=117$), in patients with an SO-FMC ≤ 15 min, the median SBP was 100 mmHg and 178 mmHg ($p<0.001$), respectively; 9% and 50% ($p<0.001$) of such patients, respectively, exhibited an SBP ≥ 180 mmHg; and 43% and 10% ($p<0.001$) of such patients, respectively, had an SBP <90 mmHg. Of patients with types A ($n=124$) and B ($n=98$) AAD whose SBPs were measured both at FMC, within 15 min after symptom onset, and at hospital admission, SBPs at FMC were higher than those at hospital admission for the SBP ≥ 180 mmHg subgroups of both type A (194 mmHg vs. 159 mmHg, $p<0.001$) and type B (199 mmHg vs. 186 mmHg, $p<0.001$). Approximately 10 min after symptom onset and before hospital transfer, the measured SBPs of many patients with type A AAD were not necessarily high. However, the SBPs of cases with type B AAD were high as previously reported for SBP on admission. In addition, for the subgroup of SBP ≥ 180 mmHg at FMC within 15 min after symptom onset, SBPs at FMC were significantly higher than those at hospital admission for both types A and B; the higher SBP at symptom onset may have been partially associated with being a trigger of AD.

Keywords Aortic dissection · Type A · Type B · Hypertension

Introduction

Acute aortic dissection (AAD) is a potentially fatal cardiovascular disorder. While the etiology of AAD has been previously described, it still remains to be fully elucidated. Hypertension is considered one of the representative causes of AAD, with one possible reason being the presence of high blood pressure (BP) in patients with AAD on admission [1, 2]. However, the BP on admission may be modified by many factors, and may not reflect the BP immediately before or at symptom onset. Although it is not possible to measure BP values immediately before or at symptom onset for AAD, it

The members of the 'Tokyo CCU Network and Tokyo Acute Aortic Super Network' are listed in acknowledgements section.

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would be beneficial to know BP values at times as near as possible to symptom onset to minimize the various possible effects on BP at AAD development.

The purpose of this study was to determine whether systolic blood pressure (SBP) very early after the onset of symptoms and before hospital transfer in patients with AAD were high, and whether SBPs very early after symptom onset at first medical contact (FMC) were higher or lower compared to SBPs at hospital admission. We used three-year data derived from the Tokyo Acute Aortic Super (AAS) Network Database, which includes detailed data at FMC of patients by ambulance personnel.

Patients and methods

Study populations

We retrospectively analyzed the Tokyo AAS Network Database, which contained records of patients with AAD between October 2010 and December 2014. Of 4192 registered patients with AAD and/or aortic aneurysm with rupture or impending rupture, 1,669 were definitively diagnosed with Stanford type A AAD and 1,512 with type B. Of these, we examined those patients for whom the following data could be obtained: symptom onset time, time of FMC and SBPs at that time, and whether aortic rupture or cardiac tamponade was documented by first assessment of a computed tomography (CT) scan on admission to transfer hospitals. Finally, we selected 473 patients with type A AAD and 357 patients with type B AAD for this study in whom "duration from Symptom Onset to FMC (SO-FMC)" was within 60 min and for whom SBP at the time was known. A flow diagram of patient selection is shown in Fig. 1.

Next, to investigate whether the SBP very early after symptom onset was higher or lower compared to SBP at hospital admission, we selected 124 type A and 98 type B patients whose SBPs were measured both at FMC, that is within 15 min after symptom onset, and at hospital admission. Patients with an unmeasurable SBP were excluded from our examinations.

The Tokyo Cardiovascular Care Unit (CCU) Network is an emergent transfer system for patients with all types of cardiovascular diseases that covers the entire Tokyo Metropolitan region except the island areas. The Tokyo AAS Network was established on the basis of the Tokyo CCU Network in 2010 and the emergent transfer system for patients with especially acute aortic syndromes such as AAD and aortic aneurysms with a rupture or impending rupture. In December 2016, the Tokyo AAS Network encompassed 71 hospitals that fulfilled certain clinical criteria and received patients from ambulance units coordinated by the Tokyo Fire Department. The Tokyo AAS Network includes 12 core hospitals (available 24 h daily) and 27 supportive hospitals (availability limited but well prepared); patients suspected of or diagnosed with AAD are first referred to such hospitals.

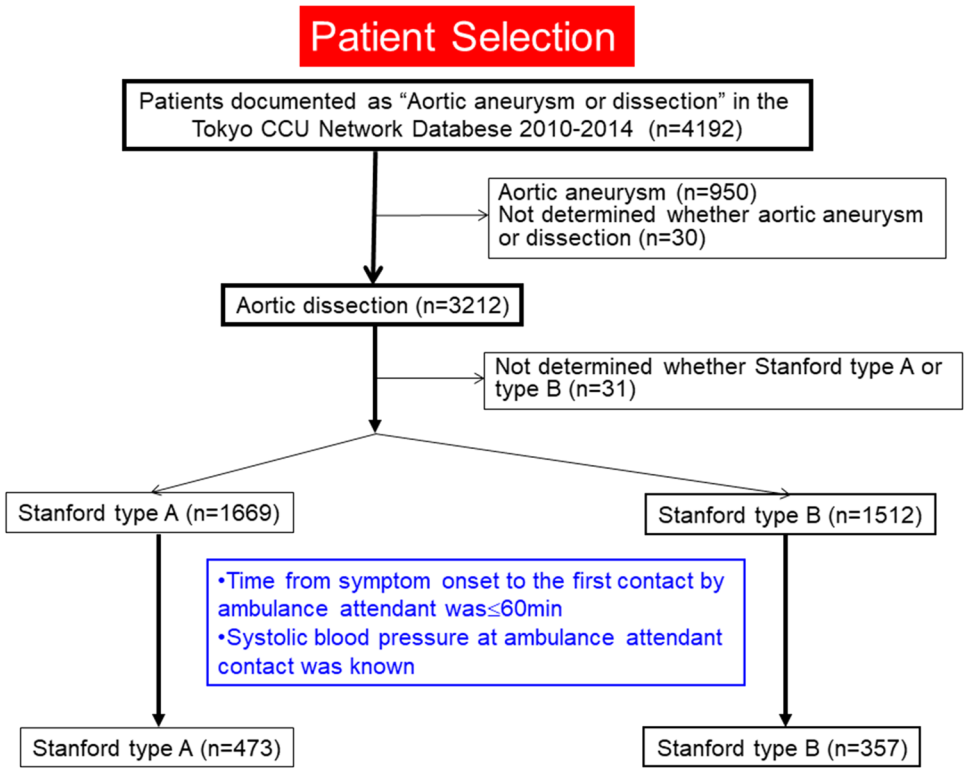

Fig. 1 Flow chart of patient selection. Of 1,669 patients with Stanford type A acute aortic dissection and 1,512 patients with type B, 473 with type A and 357 with type B were selected for this study, in whom "duration from symptom onset to first medical contact with patients by ambulance crews" was within 60 min and systolic blood pressure at that time was known

The database of the Tokyo AAS Network includes data from the Emergency and Critical Care Center and the Department of Cardiovascular Surgery in addition to the CCU. Detailed data such as SBPs can be obtained at FMC with patients by ambulance crews before hospital transfer; this is regarded as the nearest possible time to symptom onset.

Methods

First, characteristics of 473 type A and 357 type B patients with AAD were first compared for both types of AAD. Second, we divided patients into four "15-minute groups" based on the following SO-FMC: ≤ 15; 16–30; 31–45; 46–60 min, and examined the SBP at FMC among each of these four groups. We defined SBP as "0 mmHg" when the documented record for SBP was "unmeasurable", indicating severe shock status. Third, in each of the four 15-minute groups, we further divided patients into four "SBP subgroups" based on the SBP: ≥ 180; 179–140; 139–90; < 90 mmHg, and examined the number and proportion of patients belonging to each of these four subgroups.

In addition, we examined SBPs and the numbers of patients within each SBP subgroup after excluding patients with an SBP < 90 mmHg and/or cardiac tamponade and/or aortic rupture on admission, presumed to be in response to abnormal factors that modified the SBP at AAD development.

Next, we compared SBPs at FMC within 15 min after symptom onset and at hospital admission. First, overall differences between SBPs at FMC and hospital admission for types A and B patients were examined. Second, in each SBP subgroup, ≥ 180; 179–140; 139–90; < 90 mmHg, differences between SBPs at FMC and hospital admission were also examined.

Finally, the relationship between the presenting SBP of each SBP subgroup and in-hospital mortality for both A and B type AAD cases was examined.

This study was a prefecture-based multicenter cohort registry study. Data collection was carried out by the opt-out method of the Tokyo CCU Network website. The institutional review board of each member of the Tokyo CCU Network approved the use of patient data, which was automatically collected without patient name or ID number and then fixed after cleaning and arrangement. Thus, it was not possible to link patient data and the corresponding identification number in the Tokyo AAS Network Database. The ethical committee of the Tokyo Metropolitan CCU Council approved this study.

Statistical analysis

Continuous variables except for SBPs were expressed as mean ± standard deviation. SBPs were analyzed by a non-parametric method since SBPs were assessed to be "0 mmHg" when database records of SBPs were documented as "unmeasurable". Therefore, SBPs were expressed as medians (25th percentile–75th percentile). Differences in continuous variables between two unpaired groups were calculated using Student's *t* test and a Mann–Whitney *U* test. Differences in median values for continuous variables between two paired groups were calculated using a Wilcoxon signed-rank sum test. Categorical variables were expressed as numbers (%) and were compared using Fisher's exact test. SPSS for Windows, Version 16.0 (SPSS Inc., Chicago, IL, USA), was used for all statistical analyses. A p value < 0.05 was considered statistically significant.

Results

Characteristics of 473 type A and 357 type B AAD cases are compared in Table 1. In all patients with type A, SBPs at FMC were lower than those with type B [104 (60–143) vs. 170 (130–194) mmHg, $p < 0.001$], although mean SO-FMC values did not significantly differ. After excluding patients with an SBP < 90 mmHg and/or cardiac tamponade and/or aortic rupture on admission, SBPs in patients with type A were still lower than those with type B [138 (110–168) vs. 176 (144–198) mmHg, $p < 0.001$].

The SBPs at the FMC for each patient with type A or B AAD are shown in Fig. 2. SBPs at the FMC for patients

Table 1 Patient characteristics for type A and type B acute aortic dissection

	Type A ($n = 473$)	Type B ($n = 357$)	P value
Age (years)	68 ± 14	68 ± 13	0.657
Men (n, %)	248 (52%)	253 (71%)	< 0.001
Mean, Symptom onset to FMC time (min)	21 ± 12	23 ± 13	0.778
Median, SBP at FMC (mmHg)	104 (60–143)	170 (130–194)	< 0.001
Median, SBP at FMC without cardiac tamponade and/or aortic rupture and/or SBP < 90 mmHg (mmHg)	138 (110–168) ($n = 265$)	176 (144–198) ($n = 335$)	< 0.001
Death at discharge (n, %)	148 (31%)	18 (5%)	< 0.001

FMC first medical contact with patients by ambulance crew, *SBP* systolic blood pressure

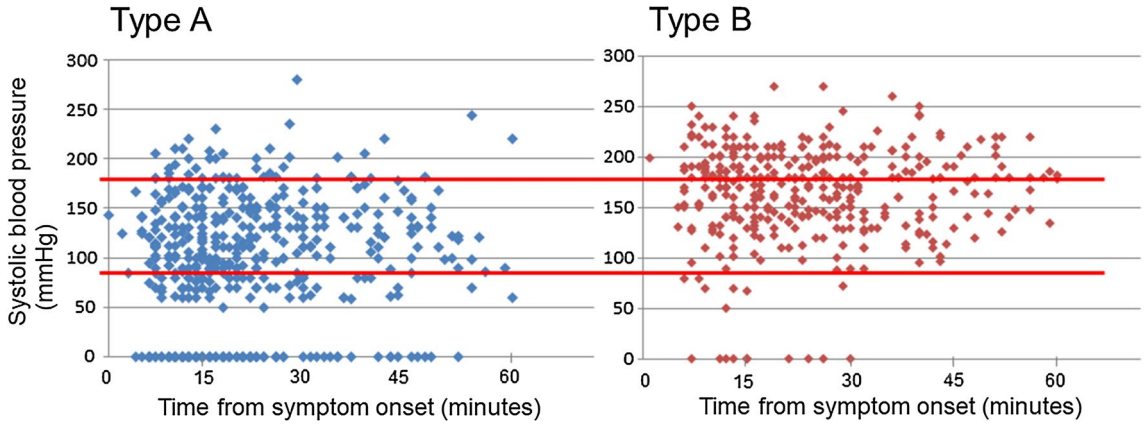

Fig. 2 Duration from symptom onset to first medical contact with patients by ambulance crews, and distribution of systolic blood pressure at first medical contact

in the 15-minute groups are shown in Table 2. For type A, among the SO-FMC ≤ 15-minute group, the mean SO-FMC was 10 ± 3 min and median SBP was 100 (0–140) mmHg, the latter being the lowest value among the overall 15-minute groups. For type B, among the SO-FMC ≤ 15-min group, the mean SO-FMC was 11 ± 3 min and median SBP was 178 (138–194) mmHg, the latter being the second highest value among these groups.

In type A, for each of the four 15-minute groups, the number and proportion of patients belonging to each SBP group are shown in Table 3. For the SO-FMC ≤ 15-minute group, 9% exhibited an SBP ≥ 180 mmHg, while 43% showed an SBP < 90 mmHg. Among the other 15-minute groups, the SBP ≥ 180 mmHg group amounted to only 10–11%, while the SBP < 90 mmHg group amounted to between 26–38%. Many cases of cardiac tamponade and aortic rupture were seen on admission, especially in patients among the SO-FMC ≤ 15-minute and SBP < 90 mmHg subgroup. The proportion of patients with type A among the SO-FMC ≤ 15-minute and SBP of 139–90 mmHg subgroup, which exhibited almost normal BP at FMC, amounted to 31%.

In type B, for each of the four 15-minute groups, the number and proportion of patients belonging to each BP group are shown in Table 3. For the SO-FMC ≤ 15-minute subgroup, 50% of patients exhibited an SBP ≥ 180 mmHg, while 10% showed an SBP < 90 mmHg. Of the other 15-minute groups, the SBP ≥ 180 mmHg subgroup amounted to

Table 2 Duration from symptom onset to FMC and SBP at FMC in type A and in type B patients

Duration from symptom onset to FMC (min)	Type A			Type B			*P* value
	Mean (min)	*N*	Median SBP (mmHg)	Mean (min)	*N*	Median SBP (mmHg)	
≤ 15	10 ± 3	190		11 ± 3	117		0.712
			100 (0–140)			178 (138–194)	< 0.001
Without rupture and/or cardiac tamponade and/or SBP < 90 mmHg	10 ± 3	95	134 (111–169)	11 ± 3	105	180 (150–200)	< 0.001
16–30	21 ± 4	184		22 ± 4	143		0.213
			110 (70–146)			164 (140–190)	< 0.001
Without rupture and/or cardiac tamponade and/or SBP < 90 mmHg	21 ± 4	106	137 (110–160)	22 ± 5	135	170 (145–194)	< 0.001
31–45	37 ± 4	72		37 ± 4	68		0.900
			124 (70–150)			166 (130–196)	< 0.001
Without rupture and/or cardiac tamponade and/or SBP < 90 mmHg	37 ± 4	46	141 (124–166)	37 ± 4	66	168 (131–196)	0.005
46–60	51 ± 4	27		52 ± 4	29		0.258
			110 (88–131)			180 (148–202)	< 0.001
Without rupture and/or cardiac tamponade and/or SBP < 90 mmHg	50 ± 4	18	126 (110–148)	52 ± 4	29	180 (148–202)	< 0.001

FMC first medical contact with patients by ambulance crews, *SBP* systolic blood pressure

Table 3 Distribution of SBP and complications recorded in each 15-minute group, from time of symptom onset to FMC

Duration from symptom onset to FMC (min)	Total (*n*)	SBP ≥ 180 mmHg (*n*, %)	Tampo Rupture rupture	SBP 179–140 mmHg (*n*, %)	Tampo rupture rupture	SBP 139–90 mmHg (*n*, %)	Tampo rupture rupture	SBP < 90 mmHg (*n*, %)	Tampo rupture rupture
≤ 15			0						37
Type A	190	17 (9%)	0	33 (17%)	2	58 (31%)	5	82 (43%)	30
Type B	117	58 (50%)	0	29 (25%)	2 0	18 (15%)	4 0	12(10%)	2
16–30			1						13
Type A	184	19 (10%)	0	34 (18%)	0	65 (35%)	6	66 (36%)	17
Type B	143	55 (38%)	0	57 (40%)	1 1	25 (17%)	5 1	6(4%)	2
31–45			0		2		0		8
Type A	72	7 (10%)	0	22 (31%)	2	19 (26%)	0	24 (33%)	4
Type B	68	29 (43%)	0	17 (25%)	0	22 (32%)	2	0	0
46–60			0		0		1		2
Type A	27	3 (11%)	0	3 (11%)	0	14 (52%)	1	7 (26%)	0
Type B	29	16 (55%)	0	10 (34%)	0	3 (10%)	0	0	0
0–60			1		4		12		60
Type A	473	46 (10%)	0	92 (19%)	5	156 (33%)	10	179 (38%)	51
Type B	357	158 (44%)	0	113 (32%)	1	68 (19%)	3	18 (5%)	4

FMC first medical contact with patients by ambulance crews, *Tampo* cardiac tamponade, *Rupture* aortic rupture, *SBP* systolic blood pressure
SBPs were measured *at FMC*, tamponade and ruptures were assessed by CT scan *on admission*

between 38–55% of patients, while the SBP < 90 mmHg subgroup amounted to between 0–5%. Some cases of aortic rupture were seen on admission in patients among 139–90 mmHg and < 90 mmHg SBP subgroups. Of patients with type B among the SO-FMC ≤ 15-minute and SBP of 139–90 mmHg subgroup, the proportion of those that exhibited almost normal SBP at FMC amounted to 15%; these values were significantly less than for those with type A, as indicated above (31%, $p = 0.0028$).

After excluding patients with an SBP < 90 mmHg and/or cardiac tamponade and/or aortic rupture on admission, the number and proportion of patients belonging to each SBP subgroup in types A and B AAD are shown in Table 4, respectively. Of these, a higher proportion of the SO-FMC ≤ 15-minute and SBP of 139–90 mmHg subgroup was evident in type A than in type B AAD (52% vs. 17%, $p < 0.001$). Furthermore, a lower proportion of the SO-FMC ≤ 15-minute and SBP ≥ 180 mmHg subgroup was evident in type A than in type B AAD (18% vs. 55%, $p < 0.001$).

Next, comparisons of SBPs at FMC within 15 min after symptom onset and at hospital admission are shown in Table 5. Overall changes of median SBPs at FMC and hospital admission were not significant both in type A and type B AAD cases. However, for each SBP subgroup based on the SBP at FMC, SBP changes between FMC and hospital admission were not uniform. For a high BP subgroup, such as the SBP ≥ 180 mmHg subgroup, the SBP at FMC was significantly decreased at hospital admission for both types A (194 mmHg vs. 159 mmHg, $p < 0.001$) and type B (199 mmHg vs. 186 mmHg, $p < 0.001$). In contrast, for a low BP subgroup, such as the SBP < 90 mmHg subgroup, the SBP at FMC was increased at hospital admission for both types A (70 mmHg vs. 81 mmHg, $p < 0.001$) and type B (75 mmHg vs. 102 mmHg, $p = 0.125$). Figure 3 shows that higher SBP at FMC subgroups demonstrated a greater decrease in SBP while lower SBP at FMC subgroups demonstrated a greater increase in SBP. The tendency in type A AAD was the same as that in type B AAD.

Finally, the relationship between presenting SBP for each SBP subgroup and in-hospital mortality for both types A and B AAD cases is shown in Fig. 4. A lower presenting SBP was associated with a higher mortality rate for both types A and B AAD.

Discussion

The first novel finding is that the measured SBP at FMC within 15 min after symptom onset differed between types A and B AAD patients. The median SBP of patients with AAD was lower in type A than in type B, even after excluding patients with an SBP < 90 mmHg and/or cardiac tamponade and/or aortic rupture on admission, presumed to be in response to abnormal factors that modified SBP at

Table 4 Distribution of SBP without rupture, tamponade and/or SBP < 90 mmHg recorded in each 15-minute group, from time of symptom onset to FMC

Duration from symptom onset to FMC (min)	Total (*n*)	SBP ≥ 180 mmHg (*n*, %)	SBP 179–140 mmHg (*n*, %)	SBP 139–90 mmHg (*n*, %)
≤ 15				
Type A	95	17 (18%)	29 (31%)	49 (52%)
Type B	105	58 (55%)	29 (28%)	18 (17%)
16–30				
Type A	106	18 (17%)	33 (31%)	55 (52%)
Type B	135	55 (41%)	56 (41%)	24 (18%)
31–45				
Type A	46	7 (15%)	20 (43%)	19 (43%)
Type B	66	29 (44%)	17 (26%)	20 (30%)
46–60				
Type A	18	3 (17%)	3 (17%)	12 (67%)
Type B	29	16 (55%)	10 (34%)	3 (10%)
0–60				
Type A	265	45 (17%)	85 (32%)	135 (51%)
Type B	335	158 (47%)	112 (33%)	65 (19%)

SBPs were measured at FMC, ruptures were assessed by CT scan on admission

FMC first medical contact with patients by ambulance crews, *rupture* aortic rupture, *SBP* systolic blood pressure

AAD development. The second novel finding is that for the subgroup of SBP ≥ 180 mmHg at FMC within 15 min after symptom onset, SBPs at FMC were significantly higher than those at hospital admission for both types A and B.

AAD and hypertension

Although the etiology of AAD has not been fully clarified, hypertension is considered to be a representative cause of this condition. Hypertension has been reported in from 44 to 86% of patients with AAD [1–8] in previous studies (Table 6). However, we need to distinguish between two types of association of hypertension with AAD: a *past history* of hypertension (62–86%) [1, 3–8] and hypertension *on admission* (44–50%) [2, 4], i.e., the frequency of a *past history* of hypertension was higher in patients with AAD than hypertension *on admission*.

Hypertension is thought to be associated with the development of AAD in two ways: First, long-standing hypertension causes aortic medial degeneration, which is a precondition for AAD development. The mechanism whereby hypertension induces such degeneration has not been fully elucidated to date. However, one hypothesis proposes that hypertension causes decreasing blood flow in the vasa vasorum, which is reportedly abundant in the outer media of the aorta, resulting in its increasing stiffness [9]. This leads to differences of stiffness in the outer and inner media of the aorta; the shear stress that is strengthened by a fluid–structure interaction in hypertension readily separates the outer and inner media [10, 11]. This indication of the long-standing effects of hypertension on AAD development is supported by the fact that many patients with AAD have a *past history* of hypertension involving the prescription of anti-hypertensive drugs, or previously known hypertension (62–86%) [1, 3–8]. Further support is provided by the fact that left ventricular hypertrophy is often seen in patients with AAD [3, 12], which may indicate a strong association with long-standing hypertension (Table 5).

Second, hypertension is assumed to be a direct trigger for AAD development by generating an entry site. This may be based on the finding that the SBP of patients with AAD *on admission* was often high (44–50%) [2, 4]. If we can prove that high BP triggers AAD development, we should be able to demonstrate a high BP immediately before AAD development rather than *on admission*. However, it is impossible to measure the SBP at the exact time of AAD development. Furthermore, after AAD development, many factors may affect BP. First, cardiac tamponade and aortic rupture are the main causes of a shock status. Even if the BP is within a normal range on admission, the presenting BP may be affected according to the extent of pericardial effusion and bleeding from the aorta. Second, an extended dissection to the brachiocephalic artery may cause a lower measured BP. Thirty percent of patients with type A AAD reportedly exhibited different BPs between right and left arms [13]. Third, BP may be elevated by intrinsic catecholamine induced by severe chest and back pain or stress after symptom onset.

Our data highlighted that for the SBP ≥ 180 mmHg subgroup, SBPs at FMC within 15 min after symptom onset

Table 5 Changes in SBP between FMC within 15 minutes after symptom onset and hospital admission for each SBP subgroup at FMC

SBP subgroup at FMC (mmHg)	Type A					Type B				
	Total (*n*)	Median SBP at FMC (mmHg)	Median SBP at hospital (mmHg)	*P* value	Change (mmHg)	Total (*n*)	Median SBP at FMC (mmHg)	Median SBP at hospital (mmHg)	*P* value	Change (mmHg)
≥180	17	194 (182–207)	159 (132–190)	< 0.001	− 35	53	199 (186–216)	186 (173–201)	0.001	− 13
179–140	29	156 (143–169)	148 (131–156)	0.027	− 8	26	162 (150–170)	159 (138–185)	0.793	− 3
139–90	53	110 (100–122)	120 (106–143)	< 0.001	+ 10	15	127 (110–131)	140 (119–158)	0.027	+ 13
<90	25	70 (64–80)	81 (74–106)	< 0.001	+ 11	4	75 (55–80)	102 (72–80)	0.125	+ 27
Overall	124	120 (92–158)	125 (104–151)	0.218	+ 4	98	180 (150–200)	174 (140–192)	0.147	− 6

SBP, systolic blood pressure, *FMC* first medical contact

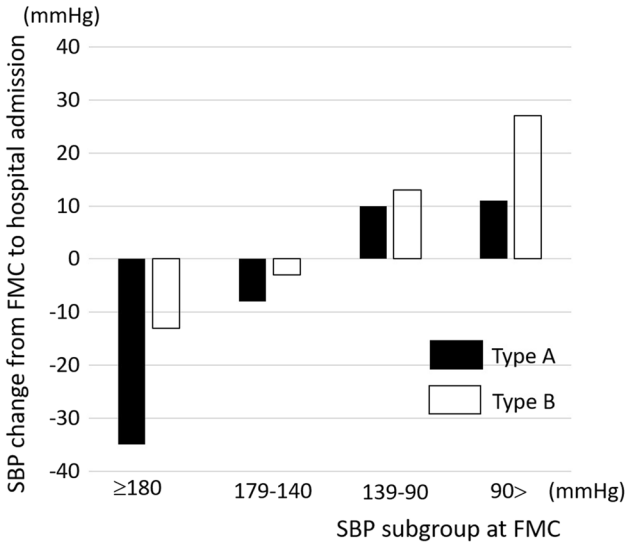

Fig. 3 Systolic blood pressure (SBP) change between first medical contact (FMC) and hospital admission. Presenting with a higher SBP at FMC showed a tendency for a greater decrease in SBP, while a lower SBP at FMC demonstrated a greater increase in SBP. The tendency in SBP change shown in type A acute aortic dissection (AAD) was similar to that in type B AAD

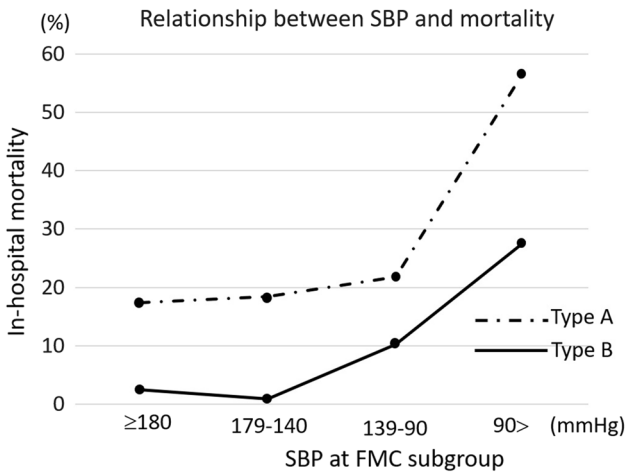

Fig. 4 Association between in-hospital mortality and systolic blood pressure (SBP) at first medical contact (FMC). A J-curve association was shown for type B acute aortic dissection (AAD), and a near J-curve-type association was shown for type A AAD

were significantly higher than SBPs at hospital admission for both types A and B AAD patients. This suggests that a higher SBP at symptom onset may have been partially associated with being a trigger of AD. In contrast, since the SBP of the SBP < 90 mmHg subgroup may have been strongly affected by aortic rupture and cardiac tamponade, and considerable unmeasurable SBP data in cardio-pulmonary arrest were excluded, the importance of a significant

Table 6 Percentages of hypertensive cases reported in previous studies of aortic dissection

Author	Publish	Study design	Hypertension		
			Past history	LV hypertrophy	On admission
Wilson [3]	1982	Retrospective	141/204 AD (69%) > 48/ 204 Control (24%) $P < 0.01$	Autopsy: AD 549 g > Control 422 g $P < 0.01$	
Meszaros [4]	2000	Prospective (27 years)	29/66 AD (70%)		46/ 66 AD (44%)
Iarussi [12]	2001	Retrospective		Echocardiography: AD 310 g > Control 156 g $P < 0.00001$	
Kojima [5]	2002	Retrospective	189/307 AD (62%)		
Suzuki [2]	2012	Retrospective (IRAD)			622/ 1240 AD (50%) A: 228/ 679 (34%) B: 393/ 561 (70%) $P < 0.001$
Li [6]	2012	Retrospective	1375/1812 AD (76%) A: 532/ 726 (74%) B: 843/1086 (78%) $P = 0.034$		A: 137 ± 26 mmHg B: 148 ± 23 mmHg $P < 0.001$
Howard [7]	2013	Prospective (10 years)	35/52 AD (67%) A: 25/37 (68%) B: 10/15 (67%) $P = 0.95$		
Pape [8]	2015	Retrospective (IRAD)	3217/4428 AD (77%) A: 2089/2953 (74%) B: 1158/1476 (81%) $P < 0.001$		
Landenhed [1]	2015	Prospective (20 years)	60/70 AD (86%)		

LV left ventricular, *AD* aortic dissection, *IRAD* International Registry of Aortic Dissection, *A* Stanford type A, *B* Stanford type B

increase in SBP between FMC and hospital admission remains unexplained.

The differences in blood pressures between type A and type B AAD

The differences in BPs between patients with type A or type B AAD have been discussed. Regarding the *pasthistory* of hypertension, one study reported no difference [7], while others reported higher BPs in type B than in type A AAD [6, 8]. Regarding hypertension *on admission*, reported BPs were higher in type B than in type A AAD [2, 6]. In the present study, the SBP at the FMC very early after symptom onset and before hospital transfer in type B was clearly high, but was not necessarily high in type A AAD.

As we mentioned above, BP is modified by many factors such as cardiac tamponade, aortic rupture, and extended dissection to the brachiocephalic artery, after AAD development. These modifications are expected to occur more often in patients with type A AAD, meaning that the BP of type A was estimated to be lower than that of type B. Furthermore, it may be speculated that neurogenic reactions occurring to a limited extent in type A AAD may be associated with the maintenance of BP. An association of BP in AAD with depressor nerve mechanisms has been previously reported [14]. For these reasons, we could not definitely state that type A AAD develops at a lower BP than type B.

In the present study, measured SBPs in patients with type A AAD were not necessarily high, even 10 min after symptom onset. We will continue to suspect the presence of AAD in patients with chest and/or back pain presenting with a normal range of BPs in a clinical setting.

Recently, the relationship between SBP and in-hospital mortality in AAD was described as showing a J-curve association.[15] Our data showed a J-curve association for type B, and an almost J-curve-like association for type A, since mortality in the SBP ≥ 180 mmHg subgroup was not very high. Thus, we should regard patients with AAD presenting with low SBP as being at very high risk of death.

Study limitations

Our study had some limitations. First, we could not determine the number of patients for whom BP measurements were made in both arms and whose measured BP was lower in the right arm. As a result, we could not completely remove the effects of extended dissection on the brachiocephalic artery causing lower measured BP in the right arm,

although we excluded patients with an SBP < 90 mmHg. Second, as we stated in previous reports regarding aortic dissection based on data from the Tokyo CCU Network Database [16], the standard of evaluation and interpretation of data was not always uniform in each hospital; for example, the definition of cardiac tamponade may not have been uniform. Some patients with pericardial effusion without hypotension may have been diagnosed as "cardiac tamponade". In addition, a diagnosis of aortic rupture was also made by the interpretation of CT findings by each doctor. Furthermore, information on whether the patients had genetically triggered aortic syndromes, congenital heart disease, and inflammatory vascular disease was not available. Such limitations exist for a study such as ours that is based on the use of multi-center data. Third, SBPs were measured at the FMC, while cardiac tamponade and aortic rupture were assessed by CT scan on admission. Therefore, it was not possible to know exactly how the SBP at the FMC was affected by cardiac tamponade and aortic rupture. Fourth, in comparing examinations of the SBP at FMC and on admission, we selected only those patients whose SBPs were measurable. Consequently, unmeasurable SBP data were excluded from the SBP < 90 mmHg subgroup in type A, which is the representative data in type A. Finally, data regarding LDL cholesterol and diabetes mellitus, and the extension of aortic dissections to the renal artery, which are thought to be associated with hypertension, were not available. When the Tokyo AAS Network was initiated, only minimal data were collected for this database.

Conclusions

Our data show that the BPs of all AAD cases were not equally high at only approximately 10 min after symptom onset and before hospital transfer. The measured SBP of many patients with type A AAD was not necessarily high. The SBP was high in type B AAD as previously reported for SBP on admission. In addition, for the subgroup of SBP ≥ 180 mmHg at FMC within 15 min after symptom onset, SBPs at FMC were significantly higher than those at hospital admission for both types A and B. This suggests that a higher SBP at symptom onset may have been partially associated with being a trigger of AD.

Acknowledgements The authors thank participating hospitals and leading members of the Tokyo CCU Network and Tokyo AAS Network. Participating Hospitals and Leading Members of the Tokyo CCU Network and Tokyo Acute Aortic Super Network: Mitsui Memorial Hospital, Jiro Aoki, Tsuyoshi Taketani; Nihon University Itabashi Hospital, Tadateru Takyama, Masashi Tanaka, Kosaku Kinoshita; Juntendo University Hospital, Hiroshi Iwata, Shizuyuki Doi; Toho University, Ohashi Medical Center, Ryo Fukui, Hiromasa Yamashita; Saiseikai Central Hospital, Toshiyuki Takahashi, Satoshi Otsubo, Kazuhiko Sekine; Showa University Hospital, Norikazu Watanabe, Atsushi Aoki, Kenji Doi; Sakakibara Heart Institute, Tetsuya Tobaru, Shuichiro Takanashi; Kosei General Hospital, Kazuhito Suzuki; St.Luke's International Hospital, Atsushi Mizuno, Hiroyasu Misumi, Shinichi Ishimatsu; Tokyo Women's Medical University Hospital, Yuichiro Minami, Arino Yaguchi; Nishiarai Heart Center Hospital, Katsumi Saito, Ahikito Sasaki; Teikyo University Hospital, Yusuke Watanabe, Tomoki Shimokawa, Tetsuya Sakamoto; The Cardiovascular Institute, Hiroaki Senba, Takashi Kunihara; Toranomon Hospital, Haruo Mitani; Toho University Omori Medical Center, Katsunori Yoshihara, Yoshinori Watanabe, Katsunori Yoshihara; Nihon University Hospital, Kazuhiro Watanabe, Mitsumasa Hata, Kenji Akiyama; Tokyo Medical University Hachioji Medical Center, Youhei Hokama, Shunya Shindo, Takao Arai; Kyorin University Hospital, Toshinori Minamishima, Hiroshi Kubota, Yoshihiro Yamaguchi; Tokyo Metropolitan Geriatric Hospital, Hajime Fujimoto, Takashi Nishimura; Tokyo Metropolitan Hiroo Hospital, Takaaki Tsuchiyama, Masazumi Watanabe, Hideaki Goto; Nippon Medical School Hospital, Shuhei Tara, Tetsuro Morota, Hiroyuki Yokota; Tokyo Women's Medical University Medical Center East, Shun Nakajima, Ryuta Asano, Tomohisa Shoko; Bokutoh Metropolitan General Hospital, Norihiro Kuroki, Susumu Ishikawa, Yuichi Hamabe; Tobu Chiiki Hospital, Takashi Tamura; Musashino Red Cross Hospital, Toshihiro Nozato, Tomoya Yoshizaki, Shinichiro Suzaki; Showa General Hospital, Shigehiro Tanaka, Yasusei Okada; Tokyo Metropolitan Tama Medical Center, Hiroyuki Tanaka, Toshiya Otsuka, Keiki Shimizu; Disaster Medical Center, Shigeo Shimizu, Tetsuya Niino, Yuichi Koido; Ome Municipal General Hospital, Ken Kurihara, Takeshi Someya, Masato Kawakami, Edogawa Hospital, Hiroshi Oohira; Tokyo Rinkai Hospital, Kazumiki Nomoto; Jikei University, Katsushika Medical Center, Takeyuki Kubota, IMS Katsushika Heart Center, Masayoshi Sakakibara, Takeyuki Kanemura; Ayase Heart Hospital, Imun Tei; Hakujikai Memorial Hospital, Yasuhiro Hirasawa; The Jikei University Hospital, Satoshi Morimoto, Kazuhiro Hashimoto; Kanto Medical Center NTT EC, Masashiro Matsushita, Ko Shibata; Ikegami General Hospital, Yasufumi Hayama, Yukio Suto; The University of Tokyo Hospital; Yumiko Hosoya, Haruo Yamauchi, Naoto Morimura; Tokyo Metropolitan Police Hospital, Shuzo Tanimoto; Mishuku Hospital, Hirotsugu Tabata; Keio University Hospital, Takashi Kohno, Hideyuki Shimizu, Tokyo Medical University Hospital, Ryosuke Ito, Hitoshi Ogino, Jun Oda; National Center for Global Health and Medicine, Hisao Hara, Tetsuya Horai, Akio Kimura; Kawakita General Hospital, Yoichi Sugimura; Itabashi Chuo Medical Center, Hiroshi Ota, Seiichiro Murata; Toshima Hospital, Hitoshi Saeki; Nishitokyo Central General; Hospital, Shigeki Ito; Higashiyamato Hospital, Ryuichi Kato, Takayuki Tatebayashi; Tokai University, Hachioji-hospital, Keiko Oikawa; Nippon Medical School Tama-Nagayama Hospital, Eitaro Kodani, Kyoko Unemoto; Tama Nambu Chiiki Hospital, Tatenori Suzuki; Tokyo Medical and Dental University, Taro Shinooka, Tsuyoshi Hachimaru, Yasuhiro Otomo; Japanese Red Cross Medical Center, Hiroshi Ikenouchi, Munehiro Hayashi; Kanto Central Hospital, Hiroshi Yamashita, Katsuhiko Kasahara; National Hospital Organization Tokyo Medical Center, Yukihiko Momiyama, Motohiko Osako, Takaaki Kikuno; JCHO Tokyo Yamate Medical Center, Michio Usui; JCHO Tokyo Shinjuku Medical Center, Seiji Ayabe; Jikei University Daisan Hospital, Takahiro Shibata; Tokyo-kita Medical Center, Takuji Katayama; Tokyo Heart Center, Joji Hosokawa; Ogikubo Hospital, Yasuhiro Ishii, Tadashi Isomura; Tama-Hokubu Medical Center, Satoshi Murasaki, Shigeharu Sawa; Meirikai Chuo General Hospital, Mizuki Hirose; The Juntendo University Nerima Hospital, Yasumasa Fujiwara, Tomohiro Iwakura; Fuchu Keijinkai Hospital, Susumu Ui; The Fraternity Memorial Hospital, Yasuhiro Takahashi; Omori Red Cross Hospital, Yasuyuki Mochida; Tokyo Nishi Tokushukai Hospital, Hiroshi Domae.

Funding The Tokyo CCU network data registry is financially supported by the Tokyo Metropolitan Government. This research did not

receive a grant from any funding agency in the public, commercial or not-for-profit sectors.

Compliance with ethical standards

Conflict of interest M.T. Reports receiving lecture fees from Daiichi Sankyo Pharmaceutical Co. Ltd., outside of the submitted work. All authors declare that there is no conflict of interest.

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