



Effects of Obesity on Outcomes of Acute Type A Aortic Dissection Repair in Japan

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Background: The prevalence of obesity among Japanese acute type A aortic dissection (ATAAD) patients and its effect on repair outcomes remain to be elucidated.

Methods and Results: The prevalence of obesity (body mass index [BMI] ≥ 30.0 kg/m²) among 1,059 patients (mean \pm SD age 64.3 \pm 12.7 years) who underwent ATAAD repair between 1990 and 2018 was compared with that among the general Japanese population (National Health and Nutrition Survey data). The prevalence of obesity among male patients (17.1% [6/35], 20.0% [18/90], and 14.4% [20/139] for those aged 20–39, 40–49, and 50–59 years, respectively) was significantly higher than that among the age- and sex-matched general population. The 1,059 patients were divided into groups according to weight (normal [BMI <25.0 kg/m²; n=742], overweight [BMI 25.0–29.9 kg/m²; n=248], or obese [BMI ≥ 30.0 kg/m²; n=69]). Comparing the normal weight, overweight, and obese groups revealed significant differences among the 3 groups in median cardiopulmonary bypass time (143, 167, and 183 min, respectively), ventilation >48 h (44.5%, 60.1%, and 78.3%, respectively), and in-hospital mortality (7.0%, 7.3%, and 17.4%, respectively), but not in 30-day survival. Shock, visceral malperfusion, operation time >360 min, obesity, and coronary malperfusion were identified as predictors of in-hospital mortality.

Conclusions: The prevalence of obesity is increased among Japanese male patients with ATAAD aged ≤ 59 years. Obesity may increase these patients' operative risk; overweight does not.

Key Words: Aortic dissection; Obesity; Overweight

Obesity is a global healthcare problem, and obese adults are likely to have various risk factors associated with cardiovascular disease, such as hypertension, diabetes, and dyslipidemia.^{1,2} Obesity and overweight are classified according to body mass index (BMI), with obesity generally defined as a BMI ≥ 30 kg/m² and overweight as a BMI of 25.0–29.9 kg/m².^{2–4} Patients who are obese are more likely than others to have obstructive sleep apnea,⁵ which has recently gained attention as a predisposing factor for acute aortic dissection.⁶ A study involving patients treated for acute aortic type A dissection (ATAAD) at the Hospital of the University of Pennsylvania showed that obese patients were younger and more likely to be male than patients with a normal BMI (<25 kg/m²).⁷ Similarly, we recently reported an increased prevalence of obesity among Japanese patients with ATAAD aged <45 years compared with patients aged >45 years.⁸ However,

the prevalence of obesity in the general population differs significantly between countries. For example, according to the latest National Health and Nutrition Examination Survey (2017–2018) data, the prevalence of obesity among US adults aged ≥ 20 years is >42%;⁹ in comparison, the reported prevalence in Asian countries is <10%.¹⁰ Thus, the etiologic effect of obesity on the development of acute aortic dissection in various Asian populations remains to be fully elucidated.

Obesity has been reported to increase mortality, morbidity, and total hospital costs following cardiac surgery.¹¹ Although growing evidence suggests an association between obesity and perioperative respiratory failure in patients with ATAAD,^{7,12–15} whether obesity influences mortality and morbidity following aortic repair for ATAAD remains controversial.^{7,16} With this question in mind, we conducted a 2-part retrospective study in which we compared the

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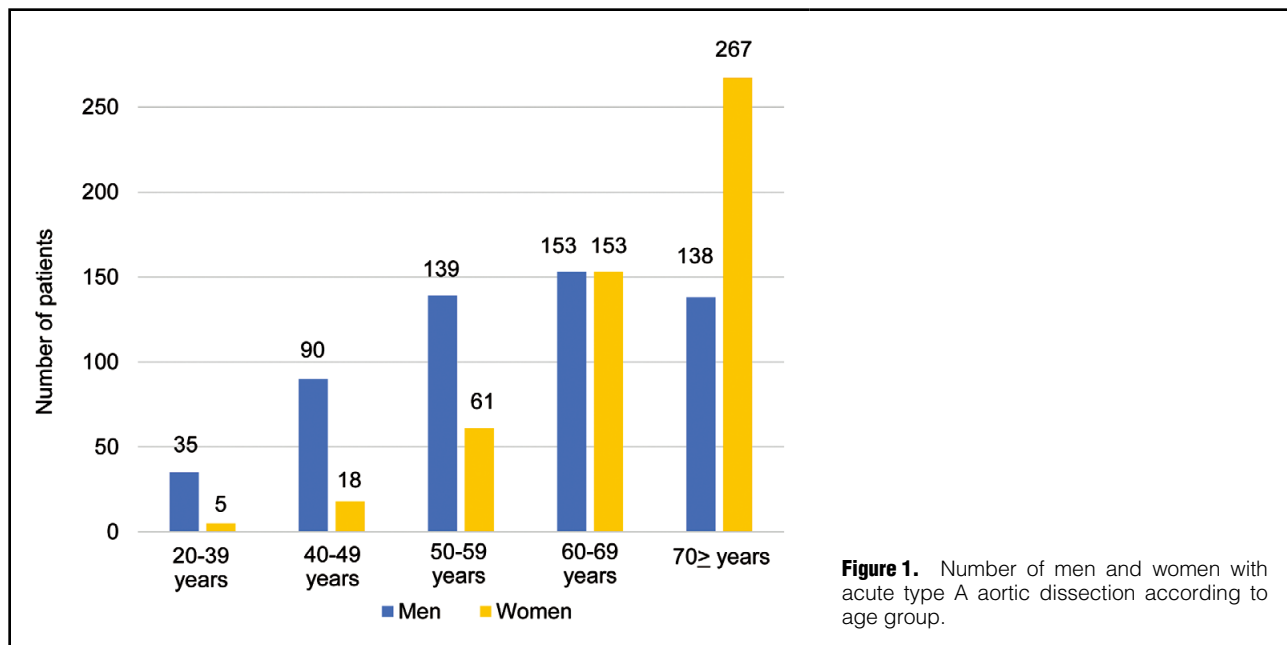


Figure 1. Number of men and women with acute type A aortic dissection according to age group.

prevalence of overweight (defined as BMI 25–29.9 kg/m²) and obesity (defined as BMI ≥30 kg/m²) among patients with ATAAD with that of the general Japanese population. We then assessed the effects of overweight and obesity on early and late outcomes of aortic repair for ATAAD.

Methods

Study Groups, Data Collection, and Study Design

Between 1990 and 2018, 1,059 patients (554 men, 505 women; mean [±SD] age 64.3±12.7 years) underwent aortic repair for ATAAD at either Jichi Medical University Hospital (Shimotsuke, Japan) or Saitama Medical Center, Jichi Medical University (Saitama, Japan). None of the 505 female patients was pregnant. Aortic dissection had been diagnosed on the basis of enhanced computed tomography or echocardiography findings, and was judged to be acute in cases in which the diagnosis was made within 2 weeks of symptom onset. Patients' clinical data were obtained from hospital records. Follow-up data were obtained for each patient from each patient's outpatient clinic or following written or telephone contact with the patient or a family member. The Institutional Review Board of Saitama Medical Center, Jichi Medical University, approved the study (Approval no. S19-033). The need for individual informed consent was waived. We also accessed National Health and Nutrition Survey (National Institute of Health and Nutrition, Tokyo, Japan) data for 1998, 2008, and 2018, data representative of the general Japanese population.¹⁷

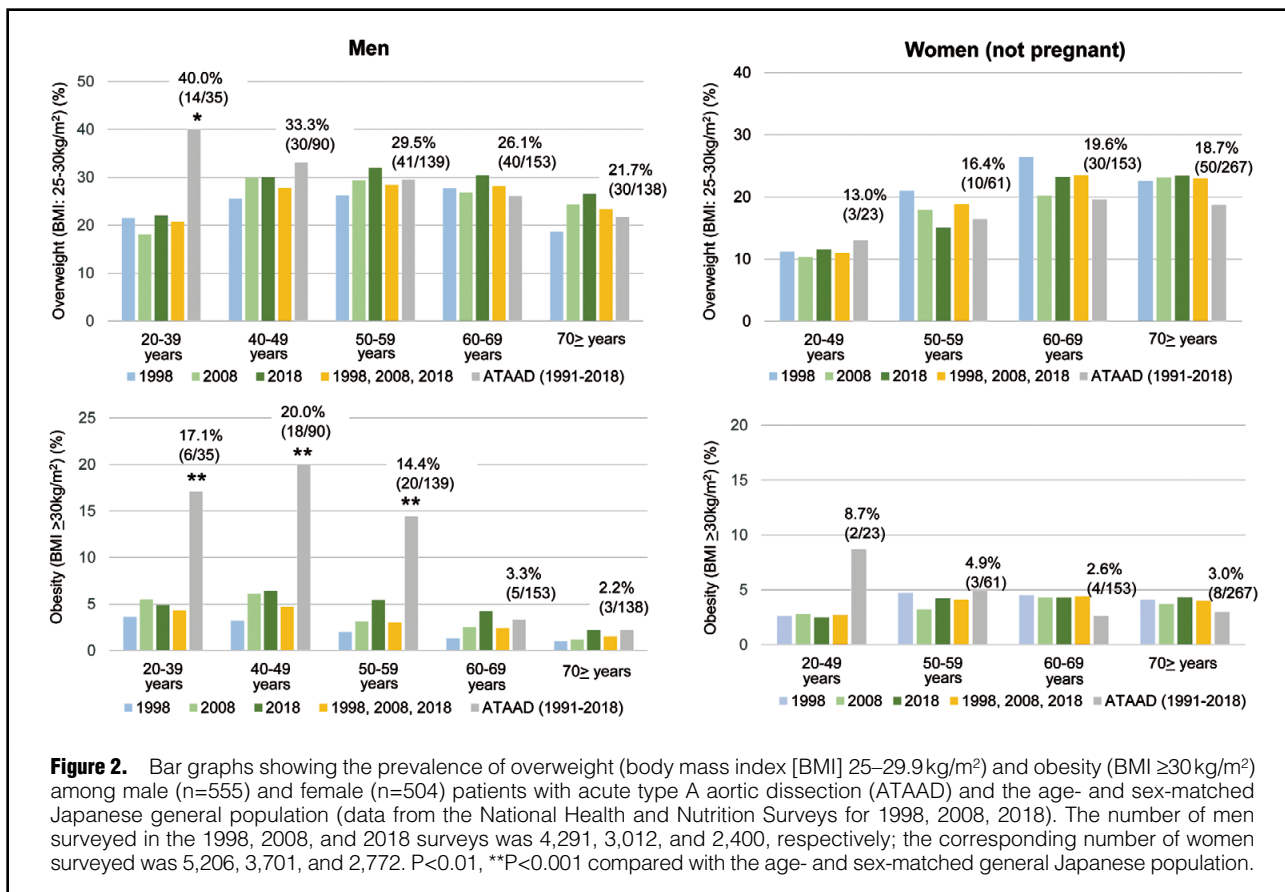
For Part 1 of the study, the 1,059 ATAAD patients were divided into age groups (20–39, 40–49, 50–59, 60–69, and ≥70 years for male patients; 20–49, 50–59, 60–69, and ≥70 years for female patients) and the prevalence of overweight, as well as obesity, was determined per age category. We also divided the general Japanese population (i.e., the surveyed population) into groups by age and determined the prevalence of overweight and of obesity per age category for each survey year and for all 3 years combined. The prevalence

of overweight and obesity among male and female patients with ATAAD was also compared with the prevalence of overweight and obesity among males and females, respectively, in the general Japanese population.

For Part 2 of the study, the 1,059 patients were divided into 3 groups according to weight status, namely normal weight (BMI <25.0 kg/m²; n=742), overweight (BMI 25.0–29.9 kg/m²; n=248), and obese (BMI ≥30.0 kg/m²; n=69), with the effects of overweight and obesity on operative outcomes assessed by comparing early and late outcomes between these 3 groups. Early outcomes included in-hospital mortality and morbidity, and late outcomes included survival and aortic event-free survival over time. We also looked for predictors of in-hospital mortality among the 1,059 patients with ATAAD.

Aortic Repair Procedures

The aortic repair procedures have been reported previously.^{8,18,19} Briefly, all procedures were performed as emergency surgeries via median sternotomy. The repair was performed by ringed intraluminal graft insertion in 15 patients treated between 1991 and 1996. All other aortic repairs involved replacement with an interposition vascular prosthesis. The femoral artery, subclavian artery, left ventricular apex, or ascending aorta was selected for arterial cannulation, depending on the dissection morphology. Bicaval venous cannulation was performed, and a left ventricular venting tube was inserted via the right upper pulmonary vein. Myocardial protection was achieved by retrograde and/or antegrade infusion of cardioplegia solution. Systemic cooling was achieved by maintaining a target rectal or bladder temperature of 20–25°C. Proximal reconstruction involved aortic valve resuspension, valve-sparing root repair, the modified Bentall procedure, or isolated aortic valve replacement. Aortic root surgery was performed in patients with root dilatation or an intimal tear located in the aortic root. The extent of replacement, whether ascending aorta replacement, hemiarch replacement, or total or partial (reconstruction of 1 or 2 branches)



arch replacement, was determined according to the location of the primary entry tear. Some patients with a narrowed true lumen in the descending aorta underwent total arch replacement using the frozen elephant trunk (FET) technique. Anterograde cerebral perfusion was performed in patients who underwent aortic arch replacement.

Statistical Analysis

Continuous variables are shown as the mean±SD or median with interquartile range, and categorical variables are shown as the number (percentage) of patients. In Part 1 of the study, the prevalence of overweight and obesity among ATAAD patients was compared with the prevalence of overweight and obesity in the age- and sex-matched general Japanese population using a binomial test. In Part 2 of the study, variables were compared between the 3 study groups, as well as between patients who died in hospital after the surgical procedure and those who did not. Between-group differences in continuous variables were analyzed using the Kruskal-Wallis test, whereas between-group differences in categorical variables were analyzed using the Chi-squared test.

Logistic regression was used to identify factors predictive of in-hospital mortality. The univariate analysis included the following perioperative variables: age, male sex, overweight, obesity, Marfan syndrome, current smoking, hypertension, diabetes, history of cerebrovascular disease, hemodialysis, chronic obstructive pulmonary disease, shock (systolic blood pressure <80 mmHg), severe aortic insufficiency, organ ischemia (coronary, visceral, lower limb, or

cerebral), DeBakey classification, cannulation site (femoral artery, axillary artery, left ventricular apex, or ascending aorta), aortic root surgery, aortic arch replacement, use of FET technique, coronary artery bypass grafting, operation time >360 min, and cardiopulmonary bypass (CPB) time >180 min. Freedom from time-related events (i.e., death or an aortic event [re-dissection, reoperation, aortic rupture, or sudden death]) was estimated by the Kaplan-Meier method and analyzed using log-rank tests.

Binomial tests were performed using SAS 9.4 (SAS Institute, Cary, NC, USA). All other statistical analyses were performed using IBM SPSS Statistics version 26.0 for Windows (IBM Corp., Armonk, NY, USA). P<0.05 was considered significant.

Results

Part 1: Prevalence of Overweight and of Obesity Among Patients With ATAAD vs. the General Japanese Population

The number of male and female patients with ATAAD per age category is shown in **Figure 1**. Female patients (n=504) were significantly older than male patients (n=555; 59.6±12.9 vs. 69.4±10.5 years, respectively; P<0.001). Young female patients were rare, with only 5 female patients aged 20–39 years and 18 female patients aged 40–49 years. Approximately 75.9% (264/348) of patients were men aged ≤59 years.

The overall prevalence of overweight and obesity in patients with ATAAD was 23.4% (248/1,059) and 6.5% (69/1,059), respectively. The prevalence of overweight and

Table 1. Clinical Characteristics, Clinical Presentation, and Dissection Morphology of Patients With Acute Type A Aortic Dissection According to Weight Status				
	Normal weight (n=742)	Overweight (n=248)	Obese (n=69)	P value
Age (years)	68 [59, 75]	63 [52, 72]	50 [42.5, 55]	<0.001
Male sex	348 (46.9)	155 (62.5)	52 (75.4)	<0.001
Time from symptom onset to surgery (days)	0 [0, 1]	0 [0, 1]	0 [0, 1]	0.21
Surgery within 48 h of symptom onset	685 (92.3)	231 (93.1)	65 (94.2)	0.79
BMI (kg/m ²)	22.0 [20.0, 23.3]	26.8 [25.7, 27.9]	31.8 [30.9, 34.1]	<0.001
Marfan syndrome	23 (3.1)	5 (2.0)	2 (2.9)	0.67
Current smoking	216 (29.1)	93 (37.5)	30 (43.5)	0.005
Hypertension	511 (68.9)	190 (76.6)	60 (87.0)	0.001
Diabetes	38 (5.1)	20 (8.1)	12 (17.4)	<0.001
History of cerebrovascular disease	63 (8.5)	14 (5.6)	11 (15.9)	0.022
Hemodialysis	17 (2.3)	4 (1.6)	0 (0)	0.19
COPD	19 (2.6)	7 (2.8)	1 (1.4)	0.79
Clinical presentation				
Need for preoperative CPR	37 (5.0)	7 (2.8)	5 (7.2)	0.21
Shock (SBP <80 mmHg)	188 (26.3)	52 (21.0)	10 (14.5)	0.068
Severe aortic insufficiency	106 (14.3)	38 (15.4)	4 (5.8)	0.12
Organ malperfusion (at least 1 organ)	71 (35.3)	31 (31.6)	14 (28.6)	0.61
Coronary	56 (7.5)	21 (8.5)	4 (5.8)	0.75
Visceral	29 (3.9)	8 (3.2)	2 (2.9)	0.95
Lower limb	86 (11.6)	34 (13.7)	11 (15.9)	0.44
Cerebral	82 (11.1)	17 (6.9)	4 (5.8)	0.067
DeBaakey classification				
Type 1	647 (87.2)	229 (92.3)	64 (92.8)	0.047
Type 2	95 (12.8)	19 (7.7)	5 (7.2)	0.047
Location of entry tear^a				
Ascending aorta	489 (65.9)	141 (57.6)	29 (42.0)	<0.001
Aortic arch	103 (13.9)	42 (16.9)	14 (20.3)	0.23
Descending aorta (or unknown)	154 (20.8)	67 (27.0)	27 (39.1)	0.001

Unless indicated otherwise, data are given as the median [interquartile range] values or as number of patients (%). Normal weight was defined as body mass index (BMI) <25 kg/m², overweight was defined as BMI 25–29.9 kg/m², and obesity was defined as BMI ≥30 kg/m². ^aMultiple entry tears existed in some patients. COPD, chronic obstructive pulmonary disease; CPR, cardiopulmonary resuscitation; SBP, systolic blood pressure.

obesity among ATAAD patients and the general Japanese population per age category is given in **Supplementary Table 1** (male patients) and **Supplementary Table 2** (female patients), with that prevalence in the general Japanese population given per survey year as well as overall. **Figure 2** shows the prevalence of overweight and obesity among men and women in the general Japanese population (per survey year and overall), as well as in male and female ATAAD patients. The prevalence of overweight among male patients aged 20–39 years was significantly higher than that of age-matched men in the general Japanese population (P=0.005); this was the only group for which there was a significant difference. The prevalence of obesity among male ATAAD patients was 17.1% (6/35), 20.0% (18/90), and 14.4% (20/139) for those aged 20–39, 40–49, and 50–59 years, respectively, and these rates were significantly higher than the prevalence of obesity among age-matched men in the general Japanese population for all survey years combined (P<0.001 for all). The prevalence of obesity was low among elderly ATAAD patients (i.e., those aged 60–69 and ≥70 years), whether male or female, and was similar to that among elderly male and female people in the general Japanese population. The prevalence of obesity among

female patients aged 20–49 years was 8.7% (2/23), which was higher than the rate of 2.7% (122/4,476) among females in the general Japanese population for all survey years combined. Regardless of age, the prevalence of overweight and obesity did not differ significantly between female ATAAD patients and the general female Japanese population.

Part 2: Effects of Overweight and Obesity on Surgical Outcomes of ATAAD

Clinical characteristics, comorbidities, clinical presentations, and dissection morphology in ATAAD patients are summarized in **Table 1**. Age and sex differed significantly between the 3 groups. Patients in the obese group were more likely than those in the 2 other groups to be young and male. Neither the interval between symptom onset and surgery nor the prevalence of Marfan syndrome differed between groups. The prevalence of current smoking and hypertension was increased in the overweight and obese groups compared with the normal weight group. The prevalence of diabetes was increased in the obese group. Clinical presentations, including preoperative hemodynamics, aortic insufficiency, and organ malperfusion, did

	Normal (n=742)	Overweight (n=248)	Obese (n=69)	P value
Arterial cannulation site				
Femoral artery	360 (48.5)	97 (39.1)	27 (39.1)	0.019
Axillary artery	287 (38.7)	103 (41.5)	22 (31.9)	0.34
Femoral artery and axillary artery	114 (15.4)	38 (15.3)	16 (23.3)	0.23
Left ventricular apex	110 (14.8)	66 (26.6)	26 (37.7)	<0.001
Ascending aorta	8 (1.1)	0 (0)	1 (1.4)	0.086
Ringed graft insertion	16 (2.2)	0 (0)	0 (0)	0.003
Proximal reconstruction				
Aortic valve resuspension	657 (88.5)	235 (94.8)	64 (92.8)	0.013
Valve-sparing root repair	2 (0.3)	1 (0.4)	0 (0)	0.78
Modified Bentall procedure	43 (5.8)	7 (2.8)	2 (2.9)	0.10
Isolated aortic valve replacement	25 (3.4)	5 (2.0)	3 (4.3)	0.45
Extent of repair				
Ascending aorta or hemiarch replacement	614 (82.7)	210 (84.7)	50 (72.5)	0.059
Aortic arch replacement	128 (17.3)	38 (15.3)	19 (27.5)	0.059
Aortic arch replacement with FET	10 (1.3)	4 (1.6)	4 (5.8)	0.087
Resection of the entry tear	573 (77.2)	183 (73.8)	43 (62.3)	0.018
Coronary artery bypass grafting	40 (5.4)	21 (8.5)	6 (8.7)	0.16
Operation time (min)	340 [280, 421]	360 [302, 435]	416 [349, 499]	<0.001
CPB time (min)	143 [119, 197]	167 [133, 218]	183 [144, 229]	<0.001
Myocardial ischemia time (min)	92 [77, 116]	98 [83, 119]	116 [89, 140]	<0.001

Unless indicated otherwise, data are given as the median [interquartile range] values or as number of patients (%). Normal weight was defined as body mass index (BMI) <25 kg/m², overweight was defined as BMI 25–29.9 kg/m², and obesity was defined as BMI ≥30 kg/m². CPB, cardiopulmonary bypass; FET, frozen elephant trunk.

	Normal (n=742)	Overweight (n=248)	Obese (n=69)	P value
30-day mortality	47 (6.3)	14 (5.6)	9 (13.0)	0.078
In-hospital mortality	52 (7.0)	18 (7.3)	12 (17.4)	0.008
Length of ICU stay ^A (days)	6 [4, 8]	6 [5, 10]	9 [6, 14]	<0.001
Length of hospital stay ^A (days)	23 [17, 31]	23 [17, 31]	27 [19, 32]	0.094
Complications				
New-onset neurological deficit	36 (4.9)	22 (8.9)	11 (15.9)	<0.001
Bleeding requiring re-exploration	30 (4.0)	10 (4.0)	5 (7.2)	0.44
Need for postoperative VA ECMO	19 (2.6)	5 (2.0)	6 (8.7)	0.039
Deep sternal wound infection	8 (1.1)	4 (1.6)	1 (1.4)	0.80
Ventilation >48 h	330 (44.5)	149 (60.1)	54 (78.3)	<0.001
Need for tracheostomy	31 (4.2)	10 (4.0)	6 (8.7)	0.21
Need for renal replacement therapy	56 (7.5)	14 (5.8)	10 (14.5)	0.049

Unless indicated otherwise, data are given as the median [interquartile range] values or as number of patients (%). Normal weight was defined as body mass index (BMI) <25 kg/m², overweight was defined as BMI 25–29.9 kg/m², and obesity was defined as BMI ≥30 kg/m². ^AAssessed for hospital survivors. ECMO, extracorporeal membrane oxygenation; ICU, intensive care unit; VA, venoarterial.

not differ between groups. The prevalence of DeBakey type 2 dissection was increased in the normal weight group. The location of the entry tear differed between groups, being significantly less common in the ascending aorta and significantly more common in the descending aorta in the overweight and obese groups than in the normal weight group.

Operative variables for each of the 3 groups are summarized in **Table 2**. The use of left ventricular apical cannulation was increased in the obese group, whereas the use of

femoral arterial cannulation was increased in the normal weight group. The use of axillary arterial cannulation did not differ between the 3 groups. Aortic valve resuspension was more commonly performed in the overweight and obese groups than in the normal weight group. Although aortic arch replacement was more commonly performed in the obese group (27.5%), the between-group difference was not significant (P=0.059). Operation time, CPB time, and myocardial ischemia time differed between the 3 groups, being significantly higher in the obese group.

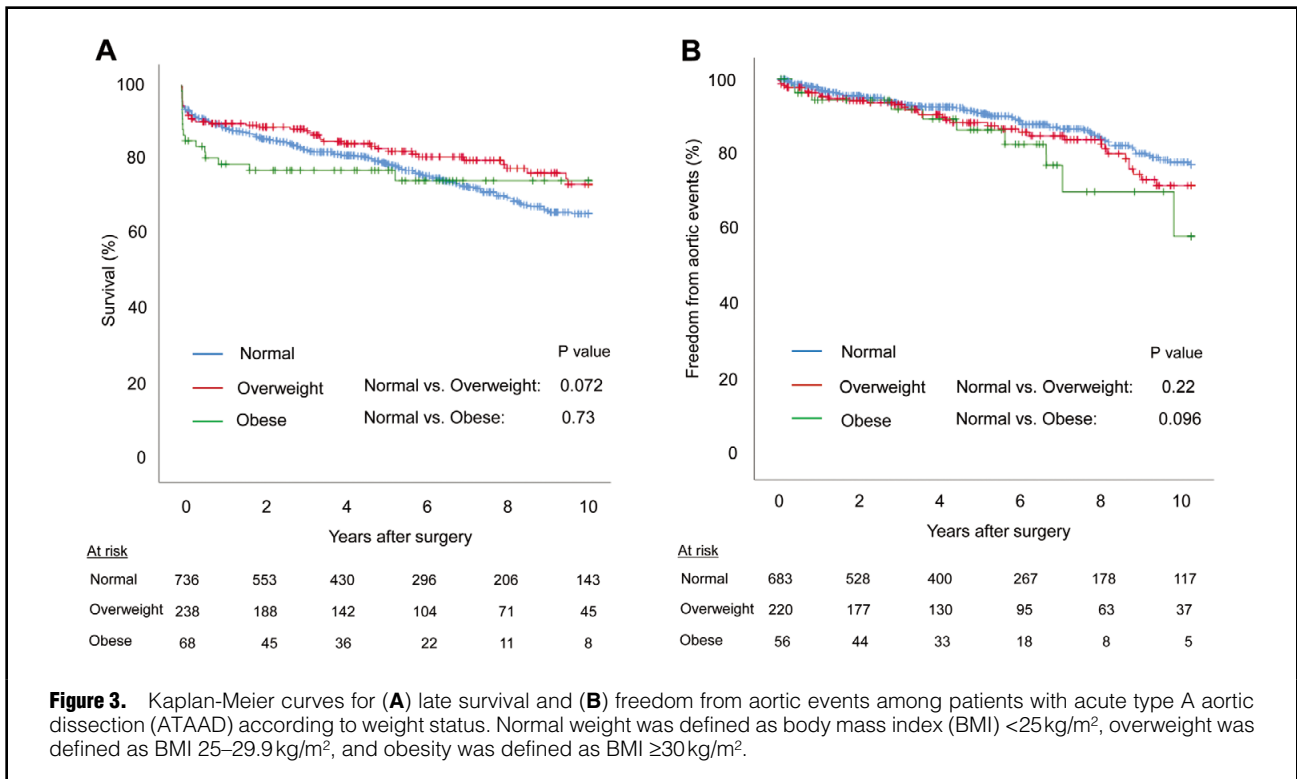


Table 4. Results of Multivariable Logistic Regression Analysis for Predictors of In-Hospital Mortality Following Aortic Repair for Acute Type A Aortic Dissection			
	P value	Odds ratio	95% CI
Shock (SBP <80 mmHg)	<0.001	5.7	3.5–9.5
Visceral malperfusion	<0.001	4.7	2.1–10.4
Operation time >360 min	<0.001	3.4	1.9–5.8
Obesity	0.005	3.0	1.4–6.2
Coronary malperfusion	0.010	2.3	1.2–4.4
DeBakey type 2 dissection	0.029	0.20	0.046–0.85

CI, confidence interval; SBP, systolic blood pressure.

Early outcomes for ATAAD patients in each of the 3 groups are summarized in **Table 3**. In-hospital mortality differed significantly, being 7.0% (52/742) in the normal weight group, 7.3% (18/248) in the overweight group, and 17.4% (12/69) in the obese group ($P=0.008$). The incidence of new-onset neurological deficit and the postoperative use of extracorporeal membrane oxygenation were increased in the obese group. There was a significant difference in the incidence of prolonged ventilation (>48 h), being 44.5% (330/742) in the normal weight group, 60.1% (149/248) in the overweight group, and 78.3% (54/69) in the obese group ($P<0.001$). Reflective of the increased incidence of postoperative complications, the intensive care unit stay was prolonged in the obese group. Although the overweight group showed a relatively high incidence of new-onset neurological deficit and prolonged ventilation, in-hospital mortality and the incidence of other postoperative complications were similar to those of the normal weight group.

Late outcomes in the normal weight, overweight, and obese groups are shown in **Figure 3**. Ten-year survival was

65.9±2.3%, 73.7±3.9%, and 74.7±5.7% in the normal weight, overweight, and obese groups, respectively. Ten-year freedom from aortic events was 77.4±2.5%, 71.9±4.6%, and 58.5±13.4% in the normal weight, overweight, and obese groups. There was no significant difference in either 10-year survival or freedom from aortic events between the 3 groups.

Characteristics of those who survived and those who died during hospitalization after surgery are given in **Supplementary Table 3**. The results of multivariable analysis for predictors of in-hospital mortality are given in **Table 4**. Shock, visceral malperfusion, operation time >360 min, obesity, coronary malperfusion, and DeBakey type 2 dissection were shown to be predictors of in-hospital mortality.

Discussion

Obesity is associated with various cardiovascular diseases, including coronary artery disease, heart failure, and atrial

fibrillation.^{20–23} Acute aortic dissection can occur against a background of a variety of medical conditions. However, the etiologic effect of obesity on acute aortic dissection has not been fully clarified. In this study we found that: (1) the prevalence of obesity was higher among male ATAAD patients aged ≤ 59 years compared with the age- and sex-matched general Japanese population; (2) the operation and CPB times were prolonged among obese patients, with both in-hospital mortality and in-hospital morbidity relatively high among these patients; and (3) the outcomes of aortic repair for overweight patients were comparable to those of normal weight patients.

Obesity has been increasing worldwide; in 2015, 19.5% of adults in Organisation for Economic Cooperation and Development (OECD) countries were found to be obese.¹⁰ The obesity rate ranges widely, from less than 6% in Korea and Japan to more than 30% in Hungary, New Zealand, Mexico, and the US.^{9,10} In addition, the age distribution of obese individuals differs between countries. For example, obesity rates have been reported not to differ by age among US adults,⁹ whereas obesity rates tend to increase with age among adults in European countries.²⁴ In assessing the prevalence of obesity in patients with aortic dissection, such international and intergenerational differences should be taken in account. The study involving patients at the Hospital of the University of Pennsylvania showed that 36% of 667 patients with ATAAD had a BMI ≥ 30 kg/m²,⁷ similar to the obesity rate reported for the general adult population of the US.⁹ Lio et al reported that, in Italy, 19% (38/201) of patients with ATAAD had a BMI ≥ 30 kg/m²,¹⁶ almost twice the 9.8% obesity rate of the general adult population in Italy.¹⁰ Li et al reported that 21.3% (86/404) of Chinese patients with ATAAD had a BMI > 30 kg/m²,¹⁵ threefold the 7.0% obesity rate of the general adult population in China general.¹⁰ In the present study, the overall prevalence of obesity among Japanese patients with ATAAD was 6.5% (69/1,059), which was greater than the 3.7% obesity rate for the general adult population in Japan.¹⁰

Novel to our study is the finding that the increase in the prevalence of overweight/obesity was limited to male patients aged ≤ 59 years. The National Health and Nutrition Survey showed age differences in the prevalence of overweight among Japanese adults, which was highest in males aged 40–49 years, whereas the prevalence of overweight among Japanese females increases with age and peaks at 50–59 years before plateauing.¹⁷ As shown in **Figure 2**, the survey-determined prevalence of obesity among Japanese females aged > 50 years was comparable to that among Japanese males aged 40–49 years, and the prevalence of obesity among Japanese females with ATAAD aged > 50 years was not greater than that of Japanese females in this age category. One possible explanation for this phenomenon may be a sex-based difference in the prevalence of obstructive sleep apnea. A recent Japanese multicenter study showed that patients with obstructive sleep apnea were predominantly male (75.2%; 2,216/2,947) and fall predominantly into 2 age groups, 40–49 years (n=546) and 50–59 years (n=550), with the peak age group for female patients with obstructive sleep apnea being 50–59 years and the number of such patients (n=202) being remarkably low by comparison.²⁵ Notably, the age-specific prevalence of obesity among the ATAAD patients in the present study matched the reported age-specific prevalence of obstructive sleep apnea in the general Japanese population. The preva-

lence of moderate to severe obstructive sleep apnea (apnea-hypopnea index > 15 /h) has been reported to be 62.6% in obese males but 21.8% in obese females.²⁶ The etiologic effect of obstructive sleep apnea on aortic dissection should be investigated in a large-scale study involving subjects matched for age, sex, and BMI.

The effect of obesity on outcomes of aortic dissection surgery has been investigated previously,^{7,13–16} with these studies showing that obese patients are more likely than non-obese patients to have perioperative hypoxia and/or postoperative respiratory complications. Unlike elective cardiac surgery patients, patients with ATAAD often present with conditions such as organ malperfusion, hemodynamic instability, and/or coagulopathy. These factors complicate perioperative management in patients with ATAAD and result in a high incidence of respiratory complications. In the present study, the incidence of prolonged ventilation (> 48 h) was 44.5% among normal weight patients, which markedly lower than in the overweight and obese patients (60.1% and 78.3%, respectively). Several factors could possibly explain the respiratory complications related to obesity. First, obese individuals tend to have physiological disadvantages in terms of respiratory function, including decreased functional residual capacity, increased airway resistance, and a high level of ventilation-perfusion mismatch.²⁷ Wu et al recently reported that the preoperative expression of proinflammatory cytokines, including interleukin (IL)-1 β , IL-6, and tumor necrosis factor- α , was increased in obese compared with non-obese ATAAD patients.¹³ Wu et al also reported the incidence of preoperative hypoxia to be increased in the obese compared with non-obese patients (94.1% vs. 35.5%; $P < 0.01$).¹³ Such preoperative inflammatory status may exacerbate intra- and postoperative lung injury in obese patients. Previous studies, as well as the present study, have shown CPB time to be significantly prolonged among obese compared with non-obese patients.^{14–16} Cooling and rewarming tend to be prolonged in obese patients. We recently reported that double arterial cannulation yielded acceptable outcomes and seems effective for the prevention and management of intraoperative malperfusion.¹⁹ Selection of optimal arterial cannulation aimed at shortening CPB time seems important in obese patients with ATAAD. Regarding respiratory care, Imber et al recommend the use of positive end-expiratory mandatory ventilation in obese patients at different phases of surgery, including before intubation, while on mechanical ventilation, and during the postoperative period (after extubation).²⁸

Obesity has been reported to increase the risk of death following cardiac surgery.^{11,29} However, a nationwide study of US patients who underwent cardiac surgery showed lower mortality among overweight and obese class I–II (BMI 30–39.9 kg/m²) patients relative to that of normal weight patients,³⁰ which supports the concept of the “obesity paradox”.³¹ In the present study, obesity was identified as a predictor of in-hospital mortality for patients with ATAAD. Lio et al reported increased in-hospital mortality among obese (n=43) compared with non-obese (n=158) ATAAD patients, with both full, unmatched analysis (in-hospital mortality 33% vs. 15%; $P = 0.01$) and propensity score-matched analysis (34 pairs; in-hospital mortality 32% vs. 12%; $P = 0.039$).¹⁶ In contrast, other investigators have reported similar rates of in-hospital mortality after aortic repair for ATAAD between obese and non-obese patients.^{7,13,15} The present study showed that the use of

extracorporeal membrane oxygenation and the incidence of new-onset neurological deficits were increased in the obese group. Others have reported an increased incidence of non-respiratory complications, including surgical site infection^{7,15} and low cardiac output syndrome,¹⁶ among obese patients with ATAAD. Careful, comprehensive perioperative management is needed for obese patients with ATAAD.

The findings of this study should be interpreted in light of the study limitations. The present study was conducted a retrospective study, and the number of patients in each age group was relatively small. A large-scale, multicenter study is needed to confirm our findings. We also note that the prevalence of obstructive sleep apnea was not assessed in the patients with ATAAD because we could not obtain the information necessary to ensure that the diagnostic criteria for obstructive sleep apnea were met.³² Further, we did not perform a subanalysis of outcomes according to the degree of obesity among patients in the obese group because there were only 10 patients who were morbidly obese (BMI ≥ 35 kg/m²) in this group.

In conclusion, we found that the overall prevalence of overweight and obesity in patients with ATAAD was 23.4% and 6.5%, respectively. An increased prevalence of obesity, relative to that of the general male Japanese population aged ≤ 59 years, was observed only among male patients aged ≤ 59 years. Patients in the obese group had prolonged CPB and operation times, as well as increased in-hospital mortality and morbidity. In contrast, the overweight group did not show worse outcomes, except for a relatively high incidence of prolonged ventilation. Knowing the effects of overweight and obesity on outcomes may help clinicians optimize the postoperative management of patients who undergo aortic repair for ATAAD.

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Disclosures

None.

IRB Information

This study was approved by the Institutional Review Board (IRB) of Saitama Medical Center, Jichi Medical University (IRB no. S19-033).

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Supplementary Files

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