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Original Article

Factors associated with in-hospital mortality and morbidity of patients with dissection of aorta type A, undergoing repair surgery

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Abstract

Aim: Acute aortic dissection type A (AADA) is a life-threatening emergency with high mortality rates. Surgical intervention is the preferred and potentially life-saving treatment, but perioperative mortality remains a significant concern. Identifying the risk factors associated with surgical mortality, morbidity, and survival rates is essential. Therefore, this study aimed to characterize the preoperative and intraoperative risk factors for death during surgical repair of AADA.
Material and Methods: We included 64 consecutive patients who underwent surgical repair between April 2013 and March 2021 in a tertiary heart center. Perioperative characteristics and variables were collected and analyzed to find any correlation between them and in-hospital Outcomes.
Results: Aortic dissection surgery was performed on an average of 8 patients annually, accounting for approximately 1.7% (64/3757) of all open-heart surgery cases. The in-hospital mortality rate was 28% (18/64). The main predisposing factors for in-hospital death were cardiac failure (11.1%), stroke (16.7%), uncontrollable hemorrhage (27.8%), renal failure (11.1%), respiratory failure (11.1%), and postoperative multi-organ failure (22.2%). We found no associations between cardiopulmonary bypass duration and mortality. During the routine use of cerebral protective perfusion, we did not encounter any cases of coma. Left ventricular hypertrophy, a short distance of intimal tear to the aortic valve, and renal failure were associated with postoperative bleeding tendency.
Conclusion: Our study showed that multiple factors such as heart failure, uncontrolled bleeding, and respiratory failure increase in-hospital mortality of patients with dissection of aorta type A, but duration of surgery does not have any association with in-hospital death.

Keywords: Aortic dissection type A, surgery, mortality, risk factors

INTRODUCTION

Aortic dissection occurs when the intimal layer of the aortic wall is penetrated and the aortic wall is separated longitudinally by pulsatile flow [1]. According to the Stanford classification, aortic dissection is classified into two types: type A, when the ascending aorta is involved, and type B, when the ascending aorta is not involved by the dissection flap.

Acute aortic dissection type A (AADA) is a life-threatening emergency. Its mortality rate is 1% to 2% per hour during the first 24 to 48 hours, and 50% of patients die within the first 24 hours after diagnosis. The incidence of this disease is 5 to 30 people per million [2,3]. Surgery is the choice and life-saving therapy for patients with AADA, but despite progress in diagnostic and treatment techniques, the prevalence of complications is high and hospital mortality is about 15-35% [1,4].

It is necessary to identify the risk factors predisposing to surgical mortality and morbidity. Different risk factors and determinants of post-operative mortality have been described for this disease

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[4,5]. By progressive improvement of surgical techniques and facilities in operation rooms, we aimed to update the mortality rate of these patients and find factors associated with in-hospital mortality and morbidity of patients with dissection of aorta type A.

MATERIAL AND METHODS

This retrospective cohort study was approved by the National Ethics Committee with the code of IR.UMSU.REC.1400.103, all patients with definite diagnosis of AADA who were referred to our tertiary Heart Center from 2013 to 2021 were included.

Patient history, including smoking history, hypertension, and diabetes, was obtained. Shortness of breath was measured based on New York Heart Association (NYHA) criteria, and the level of consciousness was measured based on Glasgow criteria. During the examination, the presence of lower extremity ischemia symptoms, such as paresthesia, pain, and lack of pulse, were checked. Echocardiography findings were recorded. The presence of cardiac arrhythmia, including atrial fibrillation, ventricular tachycardia, and heart block, as well as evidence of aorta inflammation, including adhesion, swelling, redness of secretions, and the thickness of the aortic wall, were noted. Neurological disorders, such as cognitive impairment, including memory concentration, coma, and stroke during hospitalization, were also documented. Additionally, information on the number of days under ventilator and the number of days of hospitalization in the intensive care unit (ICU) were taken from the patients' files.

Out of the 70 patients (44 men and 26 women) diagnosed and referred for surgery during this period, two patients did not accept the surgery and four patients died before being transferred to the operating room. Sixty-four consecutive patients underwent surgery for AADA repair.

AADA was defined by confirmation of an intimal flap separating the two lumens in the ascending aorta. The acute type of the disease is defined by the onset of symptoms in the last 14 days.

The operation was performed via median sternotomy, peripheral artery cannulation with venous return through the right atrium, and cardiopulmonary bypass. Body temperature was monitored via the esophagus and bladder, and profound hypothermia was achieved when the bladder temperature reached 18-25°C. After aortic clamping, the ascending aorta was opened and transected to locate the intimal tear. The morphology and functioning of the aortic valve were examined. Then, in profound hypothermia and circulatory arrest, the ascending aorta was unclamped and the entire aortic arch was examined and repaired. For distal anastomosis, circulatory arrest was occasionally used during the first 3 years, but it is currently used in all patients, with retrograde methods of cerebral protection via the superior vena cava (200-300 mL/min). Patients with a creatinine level of >1.5 on admission in patients without renal blood flow impairment was defined as chronic renal failure.

Hypothermia can increase coagulation disorders and bleeding. However, in order to reduce neurological complications caused by total circulatory arrest (TCA) during open distal Dacron anastomosis, we had to use hypothermia. By using the selective antegrade cerebral perfusion (SACP) method and avoiding TCA, the severity of hypothermia can be reduced

Distal anastomoses were performed in an open manner in most cases (55 patients out of 64 patients), with systemic hypothermia and brain protection perfusion. This was mostly done using the retrograde cerebral perfusion (RCP) method, followed by assessment of the aortic arch and its branches and placement of the aortic clamp. In a few cases (9 patients), the operation was performed without TCA and distal anastomosis was performed without removing the aortic clamp. However, all these patients suffered postoperative coma.

Coronary angiography was not performed in any of the patients before surgery, and the decision to perform intraoperative coronary artery bypass grafting was made based on indirect evidence such as coronary atherosclerosis and ECG changes before surgery. None of the patients had an acute myocardial infarction according to the postoperative ECG.

In all cases of severe aortic insufficiency, Benthal's operation or valve repair along with valve commissure resuspension was used. In other cases, the method of fixing the commissure and reducing the size of the sinotubular junction using Dacron was used.

Data Analysis

Descriptive statistics for continuous variables were expressed as mean±standard deviation (SD) or median and range. Independent t-tests were used to evaluate differences in normally distributed continuous variables. For non-normally distributed continuous data, Wilcoxon Signed rank tests were used. Chi-square tests were used to assess the association between presenting clinical characteristics and a specific cause of death for categorical variables. Statistical significance was determined by a two-sided $p<0.05$. Statistical analyses were performed with SPSS version 20.

RESULTS

Between April 2013 and March 2021, 64 patients with definite diagnosis of AADA underwent surgery. Demographics and perioperative data are shown in Tables 1, and 2. The mean age of the patients was 52.6 years, with a median age of 45 for men and 65 for women.

An average of 8 AADA repairs were conducted each year, accounting for approximately 1.7% (64/3757) of all open-heart surgeries at our institution. For patients without adjunct cerebral perfusion, the median cerebral ischemic time was 27 minutes (range: 15–45 minutes). The median lowest systemic temperature was 20°C (range: 18–25°C).

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Table 1. Preoperative characteristics of the patients (n=70)

Characteristics		Patients, No. (%)
Age (years)	Men	50.1±16.1 (20-91)
	women	56.9±16.2 (21-80)
Sex (men)		44 (62.9)
Smoking		16 (22.9)
Arterial hypertension		47 (67.1)
Previous cardiac surgery		1 (1.4)
Familial history		1 (1.4)
Renal dysfunction		22 (31.4)
Marfan syndrome		10 (14.3)
NYHA III/IV dyspnea		23 (32.9)
Chest pain		65 (92.9)
Low consciousness		10 (14.3)
Asymmetric pulse		25 (35.7)
Lateral neurological signs		3 (4.3)
Peripheral ischemia		8 (11.4)
Syncope		5 (7.1)
Endotracheal intubation (in admission)		10 (14.3)
Cardiogenic shock		6 (8.6)

Table 2. Preoperative echocardiographic findings (n=70)

Characteristics		Patients, No. (%)
Ejection fraction (EF)	≥ 50%	52 (74.3)
	≤ 50%	18 (25.7)
Tamponade	Yes	23 (32.9)
	No	47 (67.1)
Intramural hematoma	Yes	7 (10)
	No	63 (90)
Aortic regurgitation	No	3 (4.3)
	Mild	9 (12.9)
	Moderate	27 (38.6)
	Sever	31 (44.3)
Aortic valve	Bicuspid	6 (8.6)
	Tricuspid	64 (91.4)
Left ventricular hypertrophy (LVH)	No	13 (18.6)
	Mild	15 (21.4)
	Moderate	24 (34.3)
	Sever	18 (25.7)
Aortic anulus diameter		23±5.1 mm
Distance of intimal tear to aortic valve		16.6±17.1 mm

The in-hospital mortality rate was 28% (18/64). The causes of death included cardiac failure (11.1%), stroke (16.7%), uncontrollable hemorrhage (27.8%), renal failure requiring dialysis (11.1%), respiratory failure (11.1%), and postoperative multi-organ failure (22.2%). Table 3 shows perioperative parameters and postoperative complications.

Table 3. Operative parameters and postoperative complications (n=64)

Characteristics		Patients, No. (%)
Arterial cannulation site	Right femoral artery	59 (92.2)
	Left femoral artery	3 (4.7)
	Right subclavian artery	2 (3.1)
Operative technique	Replacement of ascending aorta	23 (35.9)
	Replacement of ascending aorta and AV repair	28 (43.8)
	Bentall technique	13 (20.3)
Operative times	Cardiac ischemic time (min)	145±40
	Cardiopulmonary bypass time (min)	228±60
Deep hypothermic circulatory arrest (DHCA)	Yes	55 (86)
	No	9 (14)
Cerebral perfusion (n=55)	Retrograde cerebral perfusion	47 (85.5)
	Ante grade cerebral perfusion	8 (14.5)
Sever aortic inflammation (delayed admission)	Yes	15 (23.4)
	No	49 (76.6)
Concomitant procedure	Coronary artery bypass grafting	3 (4.7)
	Mitral valve repair	3 (4.7)
Mediastinal packing	Yes	20 (31)
	No	44 (69)
ICU	Days	7±7.8 (days)
	P.C	13.2±5.1 (unit)
	FFP	10.9±6.8 (unit)
	Platelet	17.7±6.5 (unit)
Postop. complications (n=62)	Neurological	23 (37.1)
	Renal failure	37 (59.7)
	Respiratory failure	27 (43.5)
	Cardiac arrhythmia	4 (6.5)
	Re-exploration for bleeding	23 (37)
Mortality	No	46 (72)
	In operation room	2 (3)
	In ICU	16 (25)
Mortality etiologies (n=18)	Cardiac failure	2 (11.1)
	Coma	3 (16.7)
	Renal failure (dialysis)	2 (11.1)
	Respiratory failure	2 (11.1)
	Bleeding	5 (27.8)
	Multiorgan failure	4 (22.2)

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We found no association between circulatory arrest time and death, but there was a significant association between circulatory arrest time and stroke (p=0.006). The median circulatory arrest time was 33.5±16.2minutes for patients who experienced a stroke and 23.2±6.6 minutes for patients who didn't develop stroke. The relationship between preoperative risk factors and postoperative complications is presented in Table 4.

In our study, 37.1% of patients experienced neurological complications. This included 16.1% with cognitive complications (such as concentration and memory issues), which were transient and completely resolved in discharged patients. Additionally, 21% of patients had neurologic lateralization complications, including 11.3% who suffered a stroke and 9.7% who fell into a coma. Out of the 6 patients who fell into a coma, 3 were discharged after recovery while 3 patients died.

The rate of kidney failure before surgery was 31.4%, and Color Doppler ultrasound was used to evaluate renal artery stenosis.

Table 4 shows the subgroup analysis of patients according to their age. Patients older than 60 years old are defined as elderly patients.

Table 4. factors affecting mortality in patients older than 60 years old

	Univariate				Multivariate			
	OR	95% C.I. for OR		p-value	OR	95% C.I. for OR		p-value
		Lower	Upper			Lower	Upper	
Age	1.018	0.986	1.052	0.272				
Gender	2.424	0.710	8.281	0.158				
Coma	5.250	1.298	21.240	0.020	2.735	0.560	13.348	0.213
Chronic kidney disease	4.114	1.091	15.522	0.037	3.029	0.634	14.481	0.165
Left ventricular hypertrophy	2.313	1.253	4.271	0.007	1.880	0.951	3.716	0.070
Pericardial effusion	1.724	1.124	2.645	0.013	1.950	0.904	4.206	0.089
Tamsonade	3.077	1.048	9.033	0.041	0.417	0.054	3.228	0.402

DISCUSSION

In our study, the male-to-female ratio was approximately 1.7:1. Similar to our study in previous studies, the proportion of men was higher, too [6,7].

The mean age of dead patients was 57.1 years compared to 49.7% of surviving patients. The mortality rate was higher in men (36.2% vs. 21.7%), but these differences were not statistically significant. The rate of postoperative complications was significantly higher in elderly patients, but there was no difference between men and women. In Wang Z. et al.'s study, the mean age of patients was 51.5 years. They reported that age and gender did not affect postoperative mortality. On the other hand, in Maitusong et al.'s study, the mean age of patients was 50.7 years, but they reported advanced age and female gender as risk factors for early death after surgery [8,9]. The rate of smoking in our study was lower; however, the rate of Marfan syndrome was higher compared to other studies [10,11]. The rate of hypertension was consistent with other studies (75% of patients had a history of chronic hypertension) [12].

Similar to our study, in one study, renal failure, and preoperative high creatinine levels have been reported as important risk factors for postoperative dialysis and mortality [13]. The mean ejection fraction of the patients was 50. Moderate to severe aortic insufficiency was present in 83% of patients, while intramural hematoma was reported in 10%. The average size of the aortic annulus was 23 mm. The rate of bicuspid valve was 8.6%, which is similar to previous studies and significantly higher than the normal population (0.5 to 1 percent). None of these factors had a significant effect on postoperative mortality and complications [14,15].

In our study, we observed that the site of the intimal tear tended to be more proximal to the aortic root in deceased patients. A short distance between the intimal tear and the aortic valve is a risk factor for postoperative neurological, renal, respiratory, and bleeding complications. Flap dissection involving the coronary ostium and aortic commissures often leads to complex root replacement surgery and subsequent complications. The problem of intimal tear at the proximal part of the arch and branches may also be a risk factor, although this factor is less mentioned in other studies [16]. Additionally, left ventricular hypertrophy was identified as an important risk factor for postoperative complications and mortality. Zuo et al. suggested that left ventricular hypertrophy is a risk factor for aortic enlargement and subsequent dissection [17].

Although Moeinpour et al. reported a mortality rate of zero for patients with mediastinal packing at the end of the aortic dissection operation [18], mediastinal packing due to bleeding is still considered a risk factor for postoperative mortality. In our study, the mortality rate for packed patients was 45%, while non-packed cases had a mortality rate of 16.7%. The cause of death for these patients was bleeding and multi-organ failure.

Inflammation of the aorta in patients with delayed referral (more than 2 days) increased postoperative mortality, possibly due to tissue fragility and bleeding after surgery. Matthews et al. reported an overall mortality rate of 21.3%, with the highest mortality rate (66.7%) observed in the group with the longest intervals between symptom onset and diagnosis/surgery [19]. We observed that in cases where the aortic dissection occurred more than 2-3 weeks ago, the inflammation is small and suturing at the repair site is easy. However, if more than a few days have passed since the dissection, the artery wall becomes fragile and suturing becomes more difficult.

Old age, hypertension, Marfan syndrome, left ventricular hypertrophy, severe inflammation of the aorta, lack of protective brain perfusion, time of TCA, and postoperative bleeding were identified as risk factors for neurological complications. In our study, the rate of neurological complications was 37.1%, including 16.1% for cognitive and memory disorders, agitation in some cases, stroke in 11.3%, and coma in 6 cases (9.7%). All 6 cases of coma were in patients who did not use cerebral perfusion. In three cases, the patient's consciousness gradually returned over time, but in three cases, it ultimately led to the patient's death.

Postoperative severe neurological complications (coma, stroke) after AADA surgery occur in 10%-20% of patients [4]. A study found that mortality was significantly increased in comatose patients, suggesting coma as an important risk factor for death in AADA, and survivors had shorter circulatory arrest durations compared to those who died [20]. In our study, the duration of systemic circulatory arrest was not related to mortality, but it was significantly associated with neurological complications. The optimal brain protection strategy during AAAD surgery is currently controversial. For circulatory arrest times less than 30 minutes, hypothermic circulatory arrest appears to be equivalent to antegrade cerebral perfusion. For longer arrest periods, adjunctive antegrade cerebral perfusion via the right axillary artery has been recommended as the preferred cerebral protection strategy in circulatory arrest cases [15,20]. In another study of non-survivors, antegrade cerebral perfusion did not decrease the risk of death due to stroke [21]. In our experience, retrograde cerebral perfusion was a more expedient option because it was simpler and required less time.

We chose to use retrograde perfusion instead of antegrade perfusion for the following reasons: First, the cannulation of the subclavian-right axillary artery takes a long time with lesser anastomosis oozing, but the retrograde method could be done in a shorter time. Second, the retrograde method was used to take out bubbles in the cerebral vessels. Third, due to the lack of observation of coma in the retrograde method, we preferred to continue using this method. With time, the statistics of cerebral protection in both retrograde and antegrade methods have increased, and the cases without cerebral perfusion have reached less than 5%. Therefore, we have decided to increase the use of the antegrade method in our center in the future [22].

In our study, the rate of renal complications was 59.7%, including a 51.6% increase in creatinine levels. Kidney failure leading to dialysis was observed in 5 cases (8.1%). Imasaka et al. reported that preoperative renal failure was a risk factor for postoperative dialysis, occurring in 15.8% of cases, and postoperative dialysis was one of the risk factors for mortality [23].

The transfusion rate of blood products due to bleeding was significantly higher in deceased patients. Massive blood transfusion in the perioperative period is usually caused by technical difficulties, undesirable anatomy, or intraoperative complications, and it affects surgical outcomes [24,25]. Inflammation of the aorta with delayed referral (more than 2 days) and a short distance between the site of intimal tear and the aortic valve have been identified as risk factors for postoperative bleeding [19].

The surgical mortality rate in our study was 28.1% (18 out of 64), with heart failure, coma, kidney failure, respiratory complications, multi-organ failure, and bleeding being the main causes. Bleeding was the most common cause, accounting for 27.2% of deaths. Our mortality rate was similar to the IRAD study (26%) and much higher than GERAADA (17%). The higher mortality rate is likely due to more cases of coma and a higher rate of postoperative bleeding. In the last 40 cases, due to the routine use of cerebral protective perfusion, we did not have any cases of coma, and we must strive to reduce the number of postoperative bleeding cases.

Knipp et al. [26] defined high-volume centers as those that performed more than 2.5 AADA surgical repairs per year; however, in an updated study, the lowest operative mortality rate was achieved in centers that performed more than 13 aortic dissection repairs per year. Our center performs 8 aortic dissection surgeries per year. AADA surgical repairs account for approximately 1.35% of all our cardiac operating room procedures and about 1.7% (64/3757) of all our open-heart surgery cases.

This research raises the effect of the distance between the intima tear site and the aortic annulus on postoperative bleeding and operative mortality, based on echocardiography and intraoperative findings. This is a new point that has not been addressed in previous articles. The authors suggest that this parameter needs further evaluation in future studies with the same number of cases.

CONCLUSION

In conclusion, we can reduce operative mortality by optimally controlling high blood pressure to reduce cases of left ventricular hypertrophy, performing timely surgery in the preoperative period to reduce cases of inflamed aorta, and routinely using cerebral protective perfusion during surgery to reduce brain complications.

Ethics Committee Approval: This retrospective cohort study was approved by the National Ethics Committee with the code of IR.UMSU.REC.1400.103.

Patient Consent for Publication: Individual informed consent was waived due to retrospective design.

Data Sharing Statement: The data that support the findings of this study are available from the corresponding author upon reasonable request.

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