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Original Article

Possible factors affecting the mortality rate in patients undergoing surgery for aortic type A dissection

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Abstract

Objectives: Aortic dissections of type A are clinical emergencies that can prove fatal if not managed promptly in specialized care facilities. Poor clinical management is the cause of approximately 1% of deaths in patients; however, with advances in clinical practice, diagnostic imaging and clinician awareness, the mortality rate has been dramatically reduced to below 30% in most international centers. We examined the potential factors involved in mortality after surgery for type A dissections.

Methods: In this descriptive-analytical study, patients who underwent acute aortic dissection surgery in the Shahid Madani Hospital of Tabriz, Iran, between March 2009 and March 2020 were evaluated. Exclusion criteria included those who died before the surgery, patients with descending aortic dissection, and high-risk patients for surgery who were candidates for medical treatment. Among 185 operated patients, 137 were included. Males comprised 62.8% of the patients. Their mean (±SD) age was 53.9 (±15.3) years.

Results: Age (p-value < 0.0001), the presence of hypertension (p-value = 0.015), the amount of packed red blood cell transfusion (p-value = 0.024) and the amount of platelet transfusion (p-value = 0.018) were associated with increased mortality. Duration of intubation, use of fresh frozen plasma, postoperative drainage, duration of intensive care unit recovery, high serum creatinine, duration of aortic clamping, brain protection method, and smoking were not associated with increased mortality.

Conclusions: These findings suggest that participants' mortality is dependent on several variables. Mortality of the patients with type A dissection can be reduced by interventions and reducing those factors.

Keywords: Aortic dissection; Mortality; Risk factors

Introduction

There is an increased risk of aortic dissection due to blood flow into the medial lining and the creation of true and false lumens. Aortic dissection may also occur by rupture of the Vaso Vasorum and bleeding of the aortic wall (1, 2). More than 90% of cases of acute dissection show acute pain in the chest or back or both which is usually severe and sudden. Painless dissections occur in a minority of patients who usually have syncope, neurological symptoms, or heart failure (3).

The foremost critical chance calculate were hypertension (1). There were independent risk factors for in-hospital mortality after an aortic dissection (ST-T elevation and massive blood transfusion) before the surgery (4). Moreover, lower-volume surgeons or centers have double mortality in the patients undergoing emergency repair of acute aortic dissection. An aortic aneurysm may cause an aortic dissection or rupture (5). A strong correlation exists between aging and the development of the disease. At the age of fifty or sixty, its prevalence reaches its height. It is twice as common among men as in women, and 80% of patients have a history of high blood pressure (6, 7).

The disease still has a 75-80% mortality rate, in spite of medical and surgical advances; chest radiography, esophageal echocardiography, CT scans, and magnetic resonance imaging (MRI). Untreated patients die 90% of the time within the first month of their illness, with 25% dying within the first 24 hours, 50% within the first week and 50% within the first month (8). In untreated cases, they have a 40% mortality at the time of presentation and 1% per hour to 90% mortality in one year. Approximately one in ten patients referred to the emergency department has an aortic dissection (9).

The results of various studies have shown that the mortality rate is 20-30% (10). One of the independent predictors of in-hospital death in patients with aortic dissection is typing A aortic dissection (11, 12). Various studies have reported that the mortality rate from type A aortic dissection surgery is 10 to 25% (13, 14). The site of rupture plays a key role in treatment and outcome. It is assumed that if the rupture is in the ascending aorta, the problem is called Stanford type A and if it is distal to the site of the left subclavian artery, the problem is called Stanford type B (15).

Type A dissections occur when tears form at the point where the aorta branches off the heart, while Type B dissections occur at the place where it intersects the aorta. Although type A dissections are the most dangerous, early detection and management greatly improve the chances of survival (16). The method of classifying type B aortic dissection based on the timing of death in the era of open surgery was to categorize them as acute (14 days) or chronic (more than 14 days) (17). Symptoms of an aortic dissection are considered acute if they occur within 14 days of onset. About half of people suffering from Stanford type A dissections die within three days, and about 10% of people who suffer from Stanford type B dissections die within one month without treatment (18).

The prevalence of aortic dissection disease and aortic valve insufficiency along it, and also the difficulties in the diagnosis of the disease and surgical treatment of patients, have been the subject of many surgeons and cardiologists discussions. More understanding of this problem can help to improve medical and surgical treatment.

Therefore, the purpose of this study was to examine the effect of possible factors involved in the mortality of patients who underwent aortic dissection.

Materials and Methods

In this descriptive research, 137 patients were selected from among of 185 operated patients who had undergone acute aortic dissection surgeries between March 2009 and March 2020 in the Shahid Madani Hospital of Tabriz. In total, 62.8% of the patients were male and 37.2% female. Their mean (±SD) age was 53.90 (±15.3) years old. Researchers reviewed the patients' records and developed a self-made questionnaire based on the questions in those records. The variables included age, gender, smoking, hypertension, diabetes, hyperlipidemia, family history of dissection, family history of coronary heart disease, history of previous coronary heart disease, cause of hospitalization, type of pain, onset of pain, the surgical team, surgical methods, duration of hospitalization, duration of intubation, amount of postoperative drainage (ml), duration of awakening in the ICU (min), duration of aortic clamp (min), amount of blood product (packed Red blood cell (PRBC), fresh frozen product (FFP), platelet (count of 200 ml PRBC, 100ml FFP or 50ml platelet pocket), duration of pain to referral (min), duration of referral to surgery (min), brain protection method, GFR status, admission time (day), in hospital mortality and one-year mortality rate.

Exclusion criteria included the patients who died before surgery, those with descending aortic dissections, and those undergone medical treatment (elder, comorbidity, being in a coma at the time of referral, etc.).

The patients with an established diagnosis of type-A dissection (a tear in the ascending aorta, with or without extend into the abdomen) were immediately taken to the operating room under general anesthesia. A sternotomy was performed, the patient's femoral artery was cannulated, and an artery was placed in their right atrium. Afterward, cardiopulmonary bypass (CBP) was established, and after cardioplegia, the heart was stopped. In cases of unstable hemodynamics, the sternum was opened, the tamponade resolved, and the femoral vein or inanimate vein was cannulated. If the aortic valve is insufficient, Bental surgery is performed. In order to see the distal graft anastomosis, the TCA, Arch, and the opening of the cerebral arteries must have been directly visible. Hypothermia has been performed for brain protection in all patients, and with regards to antegrade and retrograde cerebral perfusion, according to the physician's experience, additional brain protection methods may be employed if necessary. Using a blood supply catheter inserted into the Superior Venacava, cold blood is injected into the brain.

Analysis was performed using SPSS 20 software. To test normality, K-S test was used. Quantitative data was described using the mean and standard deviation, and qualitative data using frequency (percentage). Data were analyzed using independent t-test for quantitative analysis and Chi-square test for qualitative analysis. In the meantime, 5% was considered statistically significant. The Ethics Committee of Tabriz University of Medical Sciences under the ethical code of IR.TBZMED.REC.1392.1-9.15 approved the study protocol.

Results

The study involved 137 patients who ranged in age from 18 to 83 with the mean and standard deviation of 53.90 and ±15.3 respectively . The majority of them were men (n=86, 62.8%) and female were (n= 51, 37.2%) (Table 1). Among all the possible studied factors involved in mortality of the patients undergone aortic dissection surgery, older age (p-value < 0.0001), the presence of hypertension (p-value = 0.015), the amount of PRBC transfusion (p-value = 0.024) and the amount of platelets transfusion (p-value = 0.018) had a statistically significant effect on increased mortality.

However, some of the variables of the study including gender, history of previous or active smoking, diabetes, hyperlipidemia, previous coronary heart disease, family history of dissection or coronary heart disease, different surgical team, different type of surgery, type of brain protection, duration of aortic clamping, intubation period, amount of FFP transfusion, amount of postoperative drainage, duration of ICU stay and recovery, length of hospital stay, and increased creatinine compare to admission have not appeared to be related to increased mortality (P0.05). Accordingly, the death rate was not significantly associated with these variables. (Table 2).

Table 1. Clinical characteristics of the patients

Characteristics	
Age (years)	53.9 (±15.3)
Gender, n (%)	
Male	86 (62.8)
Female	51 (37.2)
Diabetes, n (%)	11 (8.0)
Hypertension, n (%)	87 (63.5)
Hyperlipidemia, n (%)	12 (8.8)
Smoking, n (%)	37 (27.0)
Family history of dissection, n (%)	3 (2.2)
Family history of CAD, n (%)	10 (7.3)
History of CAD, n (%)	9 (6.6)
Reason for reference, n (%)	
Chest pain	122 (89.7)
Stroke	4 (2.9)
Back pain	75 (55.1)
Hypotension	6 (4.4)
Others	20 (14.7)
Type of pain, n (%)	
Sharp	110 (80.9)
Vague	17 (12.5)

Angina	0 (0.0)
Others	11 (8.1)
The onset of pain, n (%)	
During rest	123 (90.4)
During daily activity	10 (7.4)
During exercise / heavy activity	2 (1.5)
Surgical team, n (%)	
Team A	64 (46.7)
Team B	19 (13.9)
Team C	17 (12.4)
Team D	5 (3.6)
Team E	11 (8.0)
Team F	2 (1.5)
Team G	6 (4.4)
	13 (9.5)
Type of surgery, n (%)	
AAo transposition with tube dacron graft	47 (34.3)
Bental	54 (39.4)
Bental + hemi Arch	6 (4.4)
Bental + CABG	23 (16.8)
Bental + total Arch	6 (4.4)
Others	1 (0.7)
Hospitalizing (day)	16.53 (±20.3)
Intubation (min)	10483.91 (±22783.7)
Drainage 8 hours after surgery (C.C)	963.72 (±940.5)
Drainage 24 hours after surgery (C.C)	1746.87 (±2186.6)
Time to recovery in ICU (min)	1347.61 (±5320.3)
The duration of aortic clamping (min)	150.71 (±50.5)
The amount of transfused blood (U)	
PRBC	9.95 (±8.8)
FFP	11.71 (±9.4)
Platelet	11.03 (±9.7)
The onset of pain to referral (min)	6537.35 (±22478.3)
Duration of referral to surgery (min)	1980.31 (±5556.8)
The type of brain protection, n (%)	
Antegrade	29 (21.2)
Retrograde	20 (14.6)
GFR status (mg/dl)	
Creatinine of referral time	1.55 (±1.6)
Creatinine depletion status	0.25 (±1.7)
Mortality status clearance time, n (%)	
Live	79 (58.1)
Dead	57 (41.9)
Survival of a year, n (%)	68 (56.2)
Survival of five years, n (%)	28 (51.6)
1 year Survival after discharge, n (%)	68 (91.9)

CAD: Coronary artery disease; CABG: Coronary artery bypass graft; AAO: Ascending aorta; PRBC: Packed red blood cells; FFP: Fresh frozen plasma; GFR: *Glomerular filtration rate*

Table 2. Possible risk factors for mortality related to aortic dissection surgery

Characteristics		P-value
Age (years)		< 0.001*
Live	48.3 (±14.0)	
Dead	62.2 (±12.5)	
Gender(Male), n (%)		0.560**
Live	51 (64.6)	
Dead	34 (59.6)	
Diabetes, n (%)		0.347***
Live	5 (6.6)	
Dead	6 (11.8)	
Hypertension, n (%)		0.015**
Live	44 (57.9)	
Dead	43 (78.2)	
Hyperlipidemia, n (%)		0.539**
Live	6 (7.9)	
Dead	6 (12.0)	
Smoking, n (%)		0.189**
Live	25 (33.3)	
Dead	12 (22.6)	
Family history of dissection, n (%)		0.271***
Live	3 (3.9)	
Dead	0 (0.0)	
Family history of CAD, n (%)		0.527***
Live	7 (9.1)	
Dead	3 (5.7)	
History of CAD, n (%)		0.485***
Live	4 (5.2)	
Dead	5 (9.4)	
Surgical team, n (%)		0.147***
Surgery of AAo transposition with tube dacron graft, n (%)		0.430***
Live	25 (32.1)	
Dead	22 (38.6)	
Surgery of Bental, n (%)		0.055**
Live	36 (46.2)	
Dead	17 (29.8)	
Surgery of Bental + hemi Arch, n (%)		0.240***
Live	2 (2.6)	
Dead	4 (7.0)	
Surgery of Bental + CABG, n (%)		0.893**
Live	13 (16.7)	
Dead	10 (17.5)	
Surgery of Bental + total Arch, n (%)		0.240***
Live	2 (2.6)	
Dead	4 (7.0)	
Hospitalizing (day)		0.192*

Live	18.57 (±22.1)	
Dead	13.96 (±17.2)	
Intubation (min)		0.092*
Live	7798.03 (±21407.3)	
Dead	15184.74 (±24661.2)	
Drainage 8 hours after surgery (C.C)		0.129*
Live	870.71 (±922.9)	
Dead	1145.12 (±967.3)	
Drainage 24 hours after surgery (C.C)		0.543*
Live	1663.58 (±2415.0)	
Dead	1921.55 (±1738.6)	
Time to recovery in ICU (min)		0.413*
Live	1631.55 (±6338.8)	
Dead	705.56 (±580.0)	
The duration of aortic clamping (min)		0.981*
Live	150.85 (±44.4)	
Dead	151.07 (±59.4)	
The amount of transfused PRBC (U)		0.024*
Live	8.44 (±6.2)	
Dead	12.36 (±11.2)	
The amount of transfused FFP (U)		0.064*
Live	10.41 (±7.6)	
Dead	14.04 (±11.6)	
The amount of transfused Platelet (U)		0.018*
Live	9.05 (±7.2)	
Dead	14.46 (±12.3)	
The onset of pain to referral (min)		0.267*
Live	8382.22 (±27166.8)	
Dead	3822.20 (±12296.4)	
Pain duration from referral to surgery (min)		0.597*
Live	2202.13 (±6912.5)	
Dead	1664.59 (±2629.3)	
Antegrade vs. Retrograde cerebral protection, n (%)		0.236***
Dead of Antegrade cerebral protection	13 (23.6)	
Dead of Retrograde cerebral protection	5 (9.1)	
Creatinine of referral time (mg/dl)		0.147*
Live	1.38 (±1.3)	
Dead	1.79 (±2.0)	
Creatinine at discharge status (mg/dl)		0.065*
Live	-0.01 (±1.1)	
Dead	0.66 (±2.4)	

* P-value by Independent Samples t Test.** P-value by chi-squared test.*** P-value by Fisher's exact test. CAD: Coronary artery disease; CABG: Coronary artery bypass graft

Discussion

In our study, it was found that mortality was increased by age, hypertension, the amount of packed red blood cells (PRBCs) transfused, and the amount of Platelets transfused.

In a study conducted in Germany health centers between 2006 and 2010 looked at 2137 patients who were undergone aortic dissection of acute type A, older age was directly related to increased mortality (19).

The researchers concluded that an increase in the patients' ages significantly increased their risk of death by 12% (20). In a study on 1,558 patients who had acute type-A aortic dissection surgery, Rylski et al. found that age was the most significant risk factor for morbidity (21). Using data from the International Registry of Acute Aortic Dissection Yamasaki et al. determined that death rates were higher among elderly. They explained that age has been associated with a 70 percent increase in death risks (22). There was a significant effect of the patients' age on mortality in other studies as well (23-25). The results of Fukui et al's study of 122 patients were also similar (25). Furthermore, Chiappini et al. reported that mortality rates for the patients underwent this type of surgery were significantly correlated with their age between 1976 and 2003 (26).

Contrary to the above studies, Merkle et al. reported that their study involved 240 patients, who underwent acute aortic dissections between 2006 and 2015. They found that the median ages of survived patients were 62 (51-72 years of age) and for dead patients were 67 (57-76 years of age), and the patients' ages have no impact on the patient mortality significantly (27).

In another study by Zhang et al., 360 patients were treated for an acute aortic dissection, the average age of alive patients was 56.8 (12.3), and the average age of dead patients was 58.4 (13.3). They found that there is no significant correlation between age and patient mortality (28).

In another study, 301 patients with an acute aortic dissection were analyzed between 1997 and 2007. Study data showed that 15 patients (5.8%) with an aortic dissection in the living group and three patients (7.3%) with an aortic dissection in the dying group were over the age of 80.

Thus, age was not a significant variable for the living cases or the dead cases (29). Moreover, in the study by Apaydin et al., which was conducted on 108 patients from 1993 to 2001, eight patients were over the age of 70. Due to the lower total mortality rate (0.18% in the Merkle et al. study, 21.0% in the Zhang study, 13.6% in the Goda study, and 0.25% in the Apaydin study) the age of the patient did not significantly affect mortality (27-30).

Assuming that the operative patients did not have advanced diseases or high-risk conditions, or they delayed admission to the hospital or the surgical procedure, it is unlikely that the increased mortality was caused by advancing age.

Additionally, hypertension had a statistically significant relationship with death in this study. The significant impact of hypertension on mortality in acute type-A aortic dissection patients has been documented in several studies (23, 24, 31) Hypertension can be related to the increase in the size of the dissection or increasing the chance of rupture. As opposed to the studies carried out by Merkle et al. (152 living cases (77.2%) versus 29 dead cases (67.4%)), Zhang et al (125 living cases (44.2%) versus 37 dead cases (48.1%)), Goda et al (164 living cases (63.1%) versus 32 dead cases (78.0%)), Gawinecka et al (98 cases (80%) of all the patients with a history of hypertension) and Apaydin et al (16 out of 61 cases of hypertension died (26%)) achieved opposite results, and hypertension did not increase mortality (23, 27-30).

A significant increase in mortality was also found in this study when the number of platelets and PRBCs were transfused. In the study conducted by Zhang et al., demonstrated that the unit dose of transfused platelets was significantly higher in deceased patients (28). As well, in the study by Gawinecka and colleagues a significantly higher amount of transfused blood was found in deceased patients (23). Study by Apaydin et al. revealed similar results when more units of blood were transfused in dead patients (30). However, the difference of platelets (with a median of 0 units (1-0) in the dying versus the alive cases was not significant in Merkle et al. study except for PRBC, which was higher in the dead cases. According to Merkle et al, the amount of platelets they consumed was much smaller than the amount of platelets we used (27). In Goda et al.'s study, the number of platelets injected into 38 living patients (14.6%) and seven deceased patients (17.1%) was plt*100000/L, and a significant difference between groups was found (29).

The duration of the aortic clamp was one of the factors in this study that did not show a statistically significant difference in death rates. Apaydin et al studied the effects of aortic clamping on the duration of aortic blood pressure, and they found no differences between the two groups of studies (30). It is noteworthy, however, that the study conducted by Goda et al found some opposing findings. Among the live cases, an average of 161 minutes was spent in aortic clamping (58%) while 206 minutes was spent in the death cases (96%). The average duration of the aortic clamp during a study by Merkle et al is 85 minutes (62-123/5), whereas it is 112 minutes (74-164) for the death cases. A statistically significant difference was found between the two groups when Goda et al analyzed this factor. Goda et al.'s clamping time of deceased patients, (an average of 206 minutes) was greater than that of our study (about 151 minutes). On the other hand, in Merkle et al.'s study, the clamping time of living patients (85 minutes on average) was lower than the results of the current study, which is 146 minutes on average. (27, 29).

Similarly, changes in brain protection type such as antigrid or retrograde with mortality were not statistically significant in the present study. Goda et al's study demonstrates the proportion of alive cases to dead cases as 53 (0.20%) to 11 (26.8%). Moreover, the study by Apaydin et al. reported that among 81 cases with retrograde brain protection, 24 cases (29.6%) died. As expected, our findings corroborate our own study results since there were no differences between the two groups regarding retrograde brain protection (29, 30).

Our study found that the duration of awakening in the ICU was not a significant factor in increasing the mortality rate following aortic dissection surgery. In other words, this is contrary to what is reported by Merkle et al, who reported a median mortality rate of 2.5 days (27).

The current study had some limitations. Researchers were limited by the study's time period and the utilization of different types of equipment by surgeons, as well as the surgeons' experiences.

Conclusion

To sum up, according to the results of the study, some variables such as PRBC and platelet infusion rate were associated with increased type A dissection mortality. Consequently, reducing these modifiable risk factors can reduce the mortality of type A surgery.

Conflicts of Interest

There are no conflicts of interest among the authors.

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