Outcomes of contemporary emergency open surgery for type A acute aortic dissection in elderly patients

Akihito Matsushita, MD,^a Minoru Tabata, MD, MPH,^a Toshihiro Fukui, MD,^a Yasunori Sato, PhD,^b Shigefumi Matsuyama, MD,^c Tomoki Shimokawa, MD,^c and Shuichiro Takanashi, MD^a

Objectives: We sought to evaluate surgical outcomes of type A acute aortic dissection in elderly patients.

Methods: Between January 2004 and July 2011, 422 patients underwent emergency open surgery for type A acute aortic dissection at our institution. Of those, 124 patients who were ≥ 75 years (mean age, 78.6 ± 3.4 years) were reviewed. We also reviewed 26 patients (≥ 75 years old) who were diagnosed with acute aortic dissection at our institution during the same period but who did not undergo surgery. We analyzed early and late outcomes of surgical and nonsurgical patients.

Results: The operative mortality was 4.8% (6/124), and the incidences of stroke and prolonged hospital stay (>30 days) were 17.7% (22/124) and 20.1% (25/124), respectively. The actuarial survivals at 1, 3, and 5 years were 89.3%, 84.7%, and 79.1%, respectively. Predictors of stroke are preoperative cardiopulmonary resuscitation (odds ratio, 17.5; 95% confidence interval, 3.1-98.9; $P = .001$) and previous cardiac surgery (odds ratio, 14.0; 95% confidence interval, 1.2-164.7; $P = .036$). The 30-day or in-hospital mortality of patients who were indicated for surgery but refused surgery was 63.6% (7/11).

Conclusions: Emergency open surgery for type A acute aortic dissection in elderly patients resulted in a low mortality but high incidences of stroke and prolonged hospital stay. Preoperative cardiopulmonary resuscitation and previous cardiac surgery were significant predictors of stroke. Emergency surgery is still the primary option for most elderly patients with acute aortic dissection. (*J Thorac Cardiovasc Surg* 2014;147:290-4)

Type A acute aortic dissection (AAD) is a life-threatening emergency that carries a high mortality rate without surgical treatment.¹ Immediate surgery for repair of AAD has been recommended to halt extension, improve branch flow, and prevent aortic rupture or cardiac tamponade. Surgical outcomes of AAD have been improving with increasing experience and advances in diagnosis, surgical techniques, and perioperative management.² However, most articles have reported consistently that advanced age still remains a significant determinant of mortality after surgery for AAD.³⁻⁷ Also, advanced age has been shown to be associated with neurologic complications after surgical treatment of AAD.^{3,7} On the other hand, analyses of the International Registry of Acute Aortic Dissection and the German Registry for Acute Aortic Dissection Type A have shown that conservative treatment is more likely to result in death than surgical treatment for AAD even in elderly

patients.^{6,7} These findings endorse that surgical therapy for AAD should not be denied on the basis of advanced age alone. In the absence of practice guidelines, the optimal management of elderly patients with AAD still remains poorly defined.

Thorough operative risk assessment is difficult in emergency situations. Risk scoring systems are useful to predict surgical mortality and morbidity; however, it is often difficult to collect all information necessary for scoring in emergency situations. In addition, other factors such as frailty and family/social support need to be considered, as well as comorbidities in cases of elderly patients.

In this study, we evaluated early and late outcomes of surgical and nonsurgical elderly patients with AAD and explored predictors of stroke after emergency open surgery in this group of patients.

METHODS

Patient Population

This study was approved by the institutional review board, and a waiver of informed consent was obtained. Between January 2004 and July 2011, 422 patients underwent emergency open surgery for type A AAD at Sakakibara Heart Institute. Of those, we reviewed 124 patients who were ≥ 75 years old. We also reviewed 26 patients (≥ 75 years old) who were diagnosed with type A AAD at our institution during the same period but who did not undergo surgery.

The diagnosis was made with contrast computed tomography in all patients. Type A AAD was defined by visualizing an intimal flap separating 2 lumens in the ascending aorta. The decision-making process for our cohort is shown in Figure 1. Patients with unsuccessful cardiopulmonary

From the Department of Cardiovascular Surgery,^a Sakakibara Heart Institute, Tokyo, Japan; the Clinical Research Center,^b Graduate School of Medicine, Chiba University, Chiba, Japan; and the Department of Cardiovascular Surgery,^c Teikyo University Hospital, Tokyo, Japan.

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Address for reprints: Minoru Tabata, MD, Department of Cardiovascular Surgery, Sakakibara Heart Institute, 3-16-1 Asahi-cho, Fuchu-shi, Tokyo 183-0003, Japan (E-mail: mtabata@post.harvard.edu).

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Abbreviations and Acronyms

AAD = acute aortic dissection
CPR = cardiopulmonary resuscitation
TAR = total arch replacement

resuscitation (CPR) and comatose patients without pupillary light reflex were considered inoperable. According to our routine practice, we chose conservative treatment for patients with a fully thrombosed false lumen (noncommunicating aortic dissection or intramural hematoma) and an ascending aorta with a diameter < 45 mm regardless of age.⁸ Otherwise, we offered a surgical option to patients or their family members, explaining individual risks and benefits of the surgery to them.

In surgical patients, the mean age was 78.6 ± 3.4 years, the oldest patient was 91 years old, and 94 patients (76%) were women. Thirty-one patients (25%) had cardiac tamponade, 8 patients (6.5%) had preoperative CPR, and 3 patients (2.4%) had previous cardiac surgery. Preoperative characteristics of surgical patients are shown in Table 1.

In nonsurgical patients, the mean age was 81.8 ± 5.5 years old and 17 (65%) were women. Four patients did not undergo surgery because of unsuccessful CPR or comatose condition without pupillary light reflex, 11 patients did not undergo surgery because of a fully thrombosed false lumen and an ascending aorta with a diameter < 45 mm, and 11 patients refused surgery. Those 11 patients who refused surgery were significantly older (mean age, 83.9 ± 6.1 years) than surgical patients. Also, most of them were very frail according to their medical records, although we did not evaluate frailty in an objective fashion. Baseline characteristics of patients who refused surgery are compared with those of surgical patients in Table 1.

Data Collection

Perioperative data were collected from patients' medical records. Cardiac tamponade was defined as a cardiogenic shock with a systolic blood pressure of ≤ 90 mm Hg, associated with pericardial effusion confirmed by computed tomography and/or echocardiography. Stroke was defined as a central neurologic deficit persisting for >72 hours after surgery. All strokes were confirmed by computed tomography or magnetic resonance imaging. Respiratory failure was defined as a requirement for mechanical ventilation for >48 hours postoperatively. Operative mortality was defined as any death within 30 days after surgery or before discharge. The median follow-up period was 27 months (range, 0-95 months).

Operative Strategy and Procedure

All operations were performed through a median sternotomy; the initial arterial cannula was placed mostly in the femoral artery. The left ventricular apex or axillary artery was cannulated if the femoral artery was unavailable. Our strategy of selection of the cannulation site has been described previously.⁹ In all surgical patients, a combination of antegrade and retrograde cardioplegia was used, and patients were cooled to 25°C for circulatory arrest. A single-branch prosthesis was used in ascending aortic or hemiarch replacement; a 4-branch prosthesis was used in total arch replacement (TAR).

The proximal aorta was repaired with gelatin resorcinol formaldehyde glue and double strips (vascular graft strip inside and Teflon felt strip outside) at the level of the sinotubular junction. When there was an intimal tear in the aortic root or the aortic root was dilated, the aortic root was replaced without using glue.

In ascending aortic or hemiarch replacement, the distal aortic repair and anastomosis was performed under hypothermic circulatory arrest with retrograde cerebral perfusion from the superior vena cava. The distal aorta was repaired with double Teflon felt strips and then anastomosed to the

vascular graft. After the distal anastomosis, whole-body circulation was resumed through the branch of the prosthesis and the patient was fully rewarmed to 35°C. Proximal anastomosis was performed during rewarming.

Between January 2004 and August 2006, we used the arch-first technique with retrograde cerebral perfusion in TAR ($n = 7$). Subsequently, in 2006, we introduced the stepwise distal anastomosis technique with antegrade selective cerebral perfusion and separate lower body perfusion ($n = 11$).¹⁰ The details of our current TAR techniques have been reported previously.¹⁰

Statistical Analysis

Summary statistics were constructed using frequencies and proportions for categorical data, and mean $\pm$ standard deviation or median, if appropriate, for continuous variables. Univariate analyses were carried out using a *t* test or Mann-Whitney *U* test for continuous variables and a Fisher exact test for categorical variables.

For time-to-event outcomes, the times elapsed until a first event were compared using the log-rank test, whereas the Kaplan-Meier method was used to estimate the absolute risk of each event for each group. We explored predictors of stroke using a stepwise multivariate logistic regression model. Predictors included in the initial model were age, female sex, cardiac tamponade, preoperative CPR, preoperative neurologic deficit, myocardial ischemia, limb ischemia, previous cardiac surgery, preoperative hematocrit and serum creatinine levels, and TAR. All data were analyzed according to the intent-to-treat principle, and all comparisons were planned and the tests were 2 sided. A *P* value < .05 was considered to indicate a statistically significant difference. All statistical analyses were performed by using the PASW 18.0 (IBM-SPSS Inc, Chicago, Ill).

RESULTS

Operative Outcomes

We performed ascending aortic replacement or hemiarch replacement in 106 patients (85.5%), TAR in 18 patients (14.5%), and concomitant procedures in 28 patients (22.6%): Bentall operation in 9 patients, coronary artery bypass grafting in 11 patients, aortic valve replacement in 4 patients, and other procedures in 6 patients.

Operative mortality was 4.8% (6/124). Twenty-two patients (17.7%) had newly developed stroke and 27 patients (21.8%) had respiratory failure. Median intensive care unit stay was 4 days and median length of hospital stay was 21 days; 25 patients (20.1%) stayed in the hospital for >30 days after surgery. The operative mortality of 39 patients with fully thrombosed false lumen was 0%. Operative data and outcomes are shown in Table 2.

The Kaplan-Meier analysis estimated that actuarial 1-, 3-, and 5-year survivals were 89.3%, 83.6%, and 79.1% (Figure 2). During the follow-up period, 10/22 patients who had stroke presented with improved neurologic function and eventually recovered activities of daily living to some extent. Six patients became bedridden.

Predictors of Stroke

A stepwise multivariate logistic regression model showed that significant predictors of stroke were preoperative CPR (odds ratio, 17.5; 95% confidence interval, 3.1-98.9; *P* = .001) and previous cardiac surgery (odds ratio, 14.0; 95% confidence interval, 1.2-164.7; *P* = .036). Other

FIGURE 1. Decision making for our elderly patients with type A acute aortic dissection.

factors included in the model (age, female sex, cardiac tamponade, preoperative CPR, preoperative neurologic deficit, myocardial ischemia, limb ischemia, previous cardiac surgery, preoperative hematocrit and serum creatinine levels, and TAR) were not significant predictors.

Outcomes of Nonoperated Patients

There were 26 patients (≥ 75 years old) who were diagnosed with AAD during the same period who did not undergo surgery. All of 4 inoperable patients died on the day of admission. Of 11 patients with fully thrombosed false lumen and an ascending aorta <45 mm, 1 patient (9.1%) died from pneumonia 59 days after admission. One-year actuarial survival rate of those patients was 90%. Of 11 patients who refused surgery, 7 patients (63.6%) died within 30 days after admission or before discharge. The causes of death were cardiac tamponade in 6

TABLE 1. Baseline characteristics of surgical patients and patients who refused surgery

Variables	Surgical patients (n = 124)	Patients who refused surgery (n = 11)	P value
Mean age $\pm$ SD	78.6 $\pm$ 3.4	83.9 $\pm$ 6.1	$<.001$
Age ≥ 80 y, n (%)	34 (27.4)	7 (63.6)	.019
Women, n (%)	94 (75.8)	7 (63.6)	.468
Cardiac tamponade, n (%)	31 (25.0)	2 (18.2)	.732
Required cardiopulmonary resuscitation, n (%)	8 (6.5)	0 (0)	.626
Neurologic deficit, n (%)	15 (12.1)	0 (0)	.611
Myocardial ischemia, n (%)	11 (8.9)	0 (0)	.599
Limb ischemia, n (%)	4 (3.3)	1 (9.1)	.351
Previous cardiac surgery, n (%)	3 (2.4)	1 (9.1)	.291
Mean preoperative hematocrit, %, $\pm$ SD	33.7 $\pm$ 5.8	29.2 $\pm$ 7.6	.016
Mean preoperative creatinine, mg/dL, $\pm$ SD	0.9 $\pm$ 0.6	1.2 $\pm$ 1.2	.192
Fully thrombosed false lumen, n (%)	39 (31.4)	4 (36.4)	.743

SD, Standard deviation.

TABLE 2. Operative data and outcomes

Variables	Total (n = 124)
Ascending aortic/hemiarch replacement, n (%)	106 (85.5)
Total arch replacement, n (%)	18 (14.5)
Concomitant procedures, n (%)	28 (21.8)
Bentall operation	9
Aortic valve replacement	4
Coronary artery bypass grafting	11
Other procedures	6
Mean cardiopulmonary bypass time, min; $\pm$ SD	128.7 $\pm$ 40.9
Mean aortic crossclamp time, min; $\pm$ SD	91.3 $\pm$ 34.4
Operative death, n (%)	6 (4.8)
Stroke, n (%)	22 (17.7)
Respiratory failure, n (%)	27 (21.8)
Reexploration for bleeding, n (%)	4 (3.2)
Deep sternal infection, n (%)	4 (3.2)
Median intensive care unit stay, d	4
Median length of hospital stay, d	21
Prolonged hospitalization (>30 d), n (%)	25 (20.1)

SD, Standard deviation.

patients and respiratory failure in 1 patient. Two more patients died of cardiac tamponade during the follow-up period (2 months and 9 months after onset). One-year actuarial survival rate of those patients was 10.0%.

DISCUSSION

In our elderly surgical cohort, the operative mortality was 4.8%, and 1-, 3-, and 5-year actuarial survival rates were estimated at 89.3%, 83.6%, and 79.1%, respectively. Previous studies have reported operative mortalities in elderly

FIGURE 2. Survival curve of surgical patients.

patients (the definition of elderly patient varies in each study) with AAD ranging from 13.3% to 45.6% (some studies showed 30-day or in-hospital mortality instead of operative mortality).^{1,3-7} Five-year survival rates of surgical elderly patients with AAD have been reported previously, from 44% to 48.5%.^{3,4} Our results are superior to those reported previously, which might be because of our high surgical volume of AAD. Although the association of surgical volume with outcomes for AAD has not been shown, we experienced 422 emergency open surgeries for AAD during 6.5 years at a single center, and we have established an efficient process of diagnosis and treatment of AAD.

All of 6 operative deaths were related to stroke. The incidence of stroke was 17.7% (22/124). Advanced age is known as a risk factor of neurologic complications after surgical treatment of AAD.^{3,7} Our study has shown that preoperative CPR and previous cardiac surgery were significant predictors of stroke in elderly surgical patients with AAD. Preoperative hemodynamic compromise requiring CPR could lead to a significant decrease in cerebral perfusion. Quick diagnosis and decision making of surgery for AAD are critical to minimize a chance of preoperative hemodynamic compromise. However, it is often difficult to make a diagnosis of AAD because typical symptoms and signs of AAD, such as abrupt onset of back pain, murmur of aortic regurgitation, and pulse deficits, are less common in elderly patients compared with young patients.¹¹ Previous cardiac surgery is known as a risk factor of surgery for AAD.^{12,13} However, emergency surgery has been shown to demonstrate better outcomes than conservative management even in those patients.^{12,13} More importantly, nearly half of our patients who had stroke retrieved their neurologic function and activities of daily living after rehabilitation. Considering this fact and our low operative mortality, emergency surgery can be the first choice for most elderly patients with AAD despite a high incidence of perioperative stroke.

In our elderly surgical cohort, TAR was performed in 14.5% of patients. During the same period, TAR was performed in 31.9% of younger patients (<75 years old). Although our previous study has shown excellent outcomes of TAR,¹⁰ we do not use this extended operation excessively in emergency surgery of elderly patients. Hata and colleagues¹⁴ reported excellent results of ascending aortic/hemiarch replacement with moderate hypothermia in octogenarians with AAD. Previous studies showed that a prolonged operation may increase mortality resulting from coagulopathy, cerebral ischemia, infection, and multiple organ failure.^{15,16} A simple, quick operation may be favorable for elderly patients with AAD.

In this study, a significant number of patients required prolonged hospitalization after surgery, and 6 patients (4.8%) developed significantly impaired activities of daily

living after surgery and became bedridden. Hata and colleagues⁵ described that 17% of their octogenarian AAD patients who underwent surgery became bedridden, and that their families were subjected to physical, mental, and financial stress. The family should be made aware of this possible undesirable outcome before surgery. Family support is another important factor to consider in the process of decision making for elderly patients, as well as patients' comorbidity and frailty. In addition, ethical issues make decision making difficult for elderly patients with AAD.¹⁷

The optimal therapeutic strategy for type A AAD with fully thrombosed false lumen (noncommunicating aortic dissection or intramural hematoma) is controversial. Some studies have recommended early surgery for all patients with type A intramural hematoma.^{18,19} On the other hand, other studies have shown favorable results of conservative treatment for type A intramural hematoma.^{20,21} Kaji and colleagues²⁰ reported that the in-hospital mortality of medically treated type A intramural hematoma was 7% and that the 5-year survival rate was 90%. Evangelista and colleagues²² showed that a normal aortic diameter in the acute phase is the best predictor of intramural hematoma regression without complication. We applied conservative treatment when the ascending aortic diameter was <45 mm, and none of our patients developed cardiac or vascular events during the follow-up period. However, 1 patient died of pneumonia possibly related to prolonged bed rest for conservative management. Considering 0 operative mortality of our elderly patients with fully thrombosed false lumen, the optimal management is still controversial.

Study Limitations

There are limitations of an observational nature. This is a single-institute study and there is a patient selection bias. Because most of our AAD patients were referred from other hospitals, our cohort does not include some high-risk patients who were selected as a noncandidate for surgery at other hospitals. A larger study including surgical and non-surgical AAD patients in the entire local area is necessary to obtain a complete view of AAD in the elderly.

CONCLUSIONS

Emergency open surgery for type A AAD in elderly patients resulted in low mortality but high incidences of stroke and prolonged hospitalization. Preoperative CPR and previous cardiac surgery were significant predictors of stroke. Emergency surgery is still the primary option for most elderly patients with type A AAD if the patient and family accept possible undesirable outcomes.

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