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Original Article

In-hospital and Long-Term Results of Surgery for Acute Type A Aortic Dissection: 243 Consecutive Patients

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Background: Our surgical strategies for acute type A aortic dissection (AAAD) are prompt establishment of cardiopulmonary bypass and primary entry resection. We investigated our experience with surgery for AAAD.
Methods: Between January 1997 and December 2006, 243 consecutive patients with AAAD underwent emergency surgery. Clinical and diagnostic data of these patients were analyzed retrospectively.
Results: Surgical procedures included ascending aorta or hemiarch replacement (n = 212) and total or partial arch replacement (n = 31), and those for proximal reconstruction included modified Bentall procedure (n = 8), and aortic valve replacement (n = 3). Hospital mortality was 6.9%, and entry resection was performed in 74% of patients. Actuarial survival rate at 5 and 10 years was 86% ± 14% and 77% ± 23%, respectively. A total of 13 patients required re-operation: 5, an aortic root; 3, an aortic arch; and 5, a descending aorta. Actuarial freedom from re-operation at 5 and 10 years was 95% ± 5%, and 81% ± 18%, respectively.
Conclusions: Our surgical strategy for AAAD seems to be pertinent with acceptable short- and long-term results. Since we lost 8 patients due to rupture of false lumen postoperatively, careful follow-up for a residual false lumen may improve the patients' prognosis.

Keywords: aortic dissection, aortic operation, outcomes, aortic reoperation

Introduction

Acute type A aortic dissection is a serious cardiovascular emergency that could lead to sudden death. Although there are reports showing improved surgical outcomes,[1–3] the latest report from the International Registry of Acute Aortic Dissection Investigators announced a still high in-hospital mortality rate of 23.9%.[4] Several studies have shown that a more aggressive technique, such as the routine replacement of a total arch, have resulted in better long-term outcomes by the elimination of the residual, patent false lumen.[3,5–7]

However, we believe that priority of the patient with AAAD is immediate survival, which may be accomplished by simple and less invasive operative procedures, rather than risking further aggression for already risky patient through extended surgery. Simple and less invasive operative procedures that we recommend include prompt establishment of cardiopulmonary bypass to prevent malperfusion, preservation of the aortic valve whenever possible, and aortic arch replacement in patients with an entry site located in or extending into the aortic arch. This study investigated our early and late surgical results of AAAD to validate our surgical strategy for AAAD.

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Patients and Methods

Patients

Between January 1997 and December 2006, 243 consecutive patients (127 men and 116 women) with AAAD were treated surgically at Saitama Medical Center, Jichi Medical University, Saitama, Japan. Aortic dissection was diagnosed on the basis of enhanced computed tomography (CT) or echocardiography findings, as well as transesophageal echocardiography when possible. In all patients, emergent surgery was performed within 14 days of acute onset of symptoms. 91% (221/243) of these surgeries were performed within 48 hours but the remaining 9% (22/243) were delayed due to late diagnosis or late referral to our hospital.

Our study followed the guidelines of the ethical review board of Jichi Medical University. All of the patients had previously granted permission for use of their medical records for research purposes.

Surgical procedures

All surgeries were performed within 24 hours after admission. The surgical procedure consisted of a median sternotomy with standard cardiopulmonary bypass (CPB) using a subclavian artery or femoral artery cannulation. Once CPB was established, systemic cooling was started immediately, inducing ventricular fibrillation followed by aortic clamping. Systemic cooling was continued to a rectal temperature of 20°C, during which the proximal stump was trimmed and reinforced with Teflon felt (DuPont, Parkersburg, WV). The aortic arch was then explored under circulatory arrest for confirmation of the entry site. Ascending aorta replacement (including hemiarch replacement) was performed when the entry site was contained in the ascending aorta by the open aorta technique, and partial or total arch replacement was performed when the entry site was present or extended into the aortic arch with a selective cerebral perfusion technique. When the entry site could not be identified or was presented in the descending aorta, ascending aorta replacement was performed. For patients with conspicuous dilatation of the aortic root, aortic root replacement with composite prosthesis and reimplantation of the coronary arteries by a modified Bentall technique was performed. The placement technique always included the interposition of woven collagen-impregnated or albumin-sealed grafts with Teflon felt reinforcement of the aortic stumps. Gelatin-resorcin-formalin adhesive was not used.

Table 1 Causes of in-hospital and long-term mortality

	In-hospital	Long-term
Malignancy	0	11 (4.9%)
Cardiac failure	7 (2.9%)	7 (3.1%)
Ruptured aneurysm	4 (1.6%)	4 (1.8%)
Stroke	1 (0.4%)	2 (0.9%)
Renal failure	0	2 (0.9%)
Respiratory failure	0	4 (1.8%)
Postoperative bleeding	3 (1.2%)	0
Visceral ischemia	2 (0.8%)	0
Total	17/243(6.9%)	30/226 (13%)

Number and percentage of patients are shown.

Follow-up

In-hospital data were obtained by retrospective review of hospital records. Follow-up CT was usually performed at our outpatient clinic or at one of several neighboring hospitals 6 to 12 months after hospital discharge and annually thereafter. Other follow-up data including survival time, general health condition, aortic reoperation or rupture, and cause of death were obtained from our outpatient clinic, written or telephone contact with patients or relatives, or from local cardiologists. The mean follow-up period was 4.3 ± 2.8 (0.6–10.2) years, and follow-up information were obtained from 100% of the patients.

Statistical analysis

All values are expressed as mean ± standard deviation. Between-group differences in clinical and morphological variables were analyzed by χ^2 or Fisher's exact test or by paired *t* test or Mann-Whitney *U* test. To identify independent risk factors for in-hospital mortality, multivariate logistic regression analysis was performed. Freedom from time-related events was estimated by the nonparametric actuarial Kaplan-Meier method. A *p* value of less than 0.05 was considered statistically significant. All statistical analyses were performed with SPSS 11.0.1 for Windows software (SPSS, Inc, Chicago, IL).

Results

Hospital outcomes

Seventeen patients died postoperatively, accounting for an in-hospital mortality of 6.9% (17/243). Causes of hospital mortality included cardiac failure in 7, uncontrolled bleeding in 3, rupture of false lumen in 4, visceral ischemia in 2, and stroke in 1 patient (**Table 1**). Patient profiles and preoperative morbidities are listed in **Table 2**, and procedures and operative findings are listed in **Table 3**.

Table 2 Comparison of patient characteristics and preoperative morbidities between survivors and nonsuvivors from in-hospital death

Variables	Survived (n = 226)	Death (n = 17)	*p*
Age ≥75	36 (16%)	3 (18%)	N.S.
Male-gender	117 (52%)	10 (59%)	N.S.
Marfan syndrome	5 (2%)	1 (6%)	N.S.
Redo	4 (2%)	0 (0%)	N.S.
Hypertension	156 (69%)	11 (69%)	N.S.
Hyperlipidemia	36 (16%)	3 (18%)	N.S.
Diabetes	15 (7%)	3 (18%)	N.S.
History of CVD	22 (10%)	0	N.S.
History of CAD	13 (6%)	1 (6%)	N.S.
History of smoking	84 (37%)	4 (24%)	N.S.
COPD	8 (4%)	0	N.S.
Chronic hemodialysis	1 (0.4%)	0	N.S.
Shock	68 (30%)	11 (65%)	0.003
Severe AR	17 (8%)	0	N.S.
TIA or neurological deficits	34 (15%)	3 (18%)	N.S.
Myocardial ischemia	12 (5%)	2 (12%)	N.S.
Visceral ischemia	22 (10%)	2 (12%)	N.S.
Limb ischemia	26 (11%)	4 (24%)	N.S.

Number and percentage of patients are shown.

CVD: cerebrovascular disease; CAD: coronary artery disease; COPD: chronic obstructive pulmonary disease; AR: aortic regurgitation; TIA: transient ischemic attack; N.S.: not significant

Table 3 Comparison of operative findings and procedures a between survivors and nonsuvivors from in-hospital death

Variable	Survived (n = 26)	Death (n = 17)	*p*
DeBakey classification			
Type	143 (63%)	8 (47%)	N.S.
Type	24 (11%)	1 (6%)	N.S.
Type b a) retrograde	59 (26%)	8 (47%)	N.S.
Aortic diameter >60mm	34 (15%)	1 (6%)	N.S.
Location of the intimal tear			
Ascending aorta	109 (48%)	5 (29%)	N.S.
Ascending aorta to aortic arch	43 (19%)	2 (12%)	N.S.
Aortic arch	20 (9%)	3 (17%)	N.S.
Unidentified (or Descending aorta)	54 (24%)	7 (41%)	N.S.
Entry resection	170 (75%)	10 (59%)	N.S.
Hemiarch replacement	53 (24%)	2 (12%)	N.S.
Total (partial) arch replacement	25 (11%)	3 (17%)	N.S.
Modified Bentall	8 (4%)	0	N.S.
AVR	2 (1%)	1 (6 %)	N.S.
CABG	17 (8%)	1 (6%)	N.S.
Femoral artery cannulation	132 (58%)	7 (41%)	N.S
Prolonged operation time (>6h)	102 (45%)	14 (82%)	0.007
Prolonged CPB time (>3h)	37 (16%)	7 (41%)	0.010
Massive blood transfusion (>2000 ml)	89 (39%)	7 (41%)	N.S.

Number and percentage of patients are shown.

AVR: aortic valve replacement; CABG: coronary artery bypass grafting; CPB: cardio-pulmonary bypass; N.S.: not significant

Firstly, we compared the data between survivors and nonsurvivors from in-hospital deaths. Only three factors, including preoperative shock, prolonged the operation time (more than 6 hours) and prolonged the CPB time (more than 3 hours), reached a statistically significant difference. Secondly, we utilized logistic regression analysis which revealed preoperative shock, preoperative intubation, prolonged operation time (more than 6 hours),

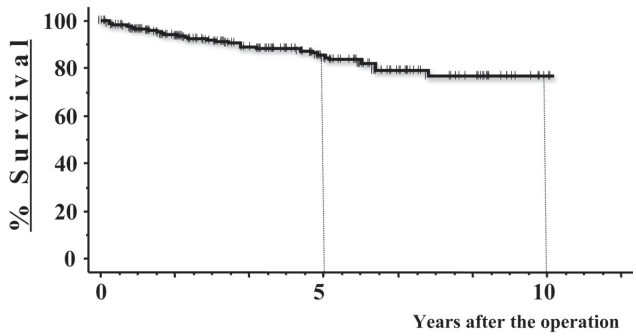

Fig. 1 Actuarial survival curves at follow-up, among hospital survivors.

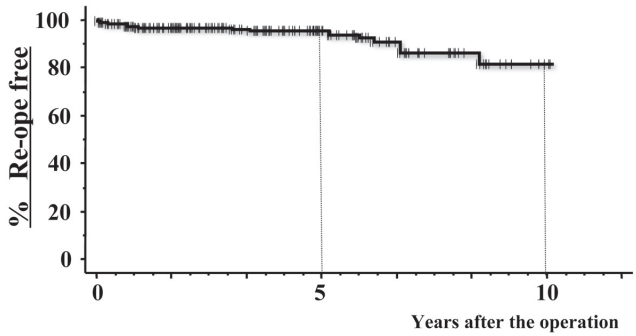

Fig. 2 Freedom from re-operation curve at follow up, among hospital survivors.

prolonged CPB time (more than 3 hours) as risk factors by univariate analysis. Finally, multivariate analysis indicated preoperative shock ($p = 0.031$) and prolonged operation time ($p = 0.026$) as independent risk factors.

The mean ICU stay was 7 ± 6 days and the mean length of hospital stay was 29 ± 23 days. Twenty-six patients (11%) appeared to have some degree of neurologic deficit including a transient neurologic deficit, postoperatively. Among them, 5 had a stroke which was confirmed by an imaging study. All patients needing percutaneous cardiopulmonary support (PCPS) had died.

Long-term survival

Thirty patients died during the follow-up period, including eleven patients by malignancy, representing the leading cause (37%, 11/30), while two patients were diagnosed during hospitalization for AAAD (**Table 1**). Cardiac failure (23%, 7/30) was the second leading cause, including three patients with myocardial infarction (n = 3), three with congestive heart failure (n = 3), and one with sudden death, which was unrelated to the distal aortic aneurysm (n = 1). Ruptured aortic aneurysm in the distal aorta that resulted in death were shown in four patients (13%, 4/30). The actuarial survival rate without in-hospital deaths, including all patients, was 86% ± 14% at 5 year, and 77% ± 23% at 10 years (**Fig. 1**).

Late reoperation for dilated false lumen of the proximal and distal aorta

Our criterion for reoperation is expansion of the distal aorta to a diameter of more than 60mm or proximal aorta dilation expressing aortic regurgitation. Eight patients (3.5%) underwent late reoperations due to dilation of the false lumen in the distal aorta (3 in the aortic arch, 5 in the descending aorta) and 5 patients (2.2%) with developed aneurismal aortic sinus with aortic regurgitation also underwent a proximal aortic replacement. A total of 13 cases underwent reoperation, including seven who had an emergency operation. Fortunately, there was no in-hospital death associated with these reoperations. Regarding high risk patients complicated by Marfan syndrome, only one out of six patients underwent proximal aortic reoperation. Freedom from distal aortic reoperation for all hospital survivors (n = 226) was 95% ± 5% at 5 year, and 81% ± 18% at 10 years (**Fig. 2**).

Discussion

With advances in surgical techniques and perioperative care, surgical outcomes of AAAD have recently improved. In-hospital mortality in this series was 6.9% (17/243), which was comparable to previous reports.[1–3] We believe that this outcome was associated with surgical strategies performed in our institution. Firstly, proximal stump formation was performed during systemic cooling with an aortic cross-clamp in place. Although aortic cross-clamp may cause further damage to the dissected aortic wall and cerebral malperfusion due to pressure rise in the false lumen, this approach contributed in reducing the cardiopulmonary bypass time. Secondly, preservation of the aortic valve was a priority whenever possible. In this series, aortic root replacement (modified Bentall operation) was performed only in 8 patients (3.3%), partly due to the small population of patients with Marfan's syndrome (6 patients, 2.4%), and limited cases with an entry site below the sino-tubular junction or sinus of valsalva.

To decrease the incidence of distal aortic reoperations, some authors recommend systematic extended or total arch replacement for the initial surgical management of AAAD, irrespective of the site of entry.[3,5–7] The main benefit of this approach is the complete resection of a

small, invisible entry site located in the aortic arch.[6] We have recently reported that the patent false lumen of the distal aorta were associated with late, distal aortic enlargement.[8] The incidence of a residual patent false lumen of the distal aorta in the same series was 64%. In accordance with the results of previous studies, in which aortic arch replacement was performed in selected patients,[9–13] other groups, which used aortic arch grafting in all patients with AAAD, reported a 27%–46% incidence of a residual patent false lumen.[3,6–7] It is possible that the low percentage of aortic arch replacements in the present series (12%, 28/243) led to the relatively high rate of residual, false lumen patency.[8]

Crawford et al. recommended replacement of the aortic arch, only when it is aneurysmic and there is a risk for impending or actual rupture of the false lumen.[14] Recently, some groups, adopting routine usage of extended aortic arch replacement, have reported high reoperation-free rates of 77%–93% at 10 years as well as excellent operative outcomes, proved by the mortality rate of 4.7% to 10%.[3,6–7] A routine approach for extended aortic arch replacement may decrease the incidence of a residual, patent false lumen. However, groups not following the routine use of an extended aortic arch, including our institution, had similar reoperation- free rates. (81% freedom from reoperation at 10 years) It also remains unclear whether this approach can decrease the need for re-operation of the distal aorta in non-routine groups considering the improvement in the survival rate.

An aggressive approach might increase operative risk as well. In the present study, in-hospital mortality for patients who underwent total or partial arch replacement was slightly higher than those who underwent ascending aorta or hemiarch replacement (11% (3/28) vs. 6.5% (14/215), $p = 0.82$). The difference was not significant. However, we consider that this risk largely outweighs the relatively low incidence of reoperation in the distal aorta and associated operative risk in the non-routine group. Our relatively conservative surgical approach seems to be reasonable for patients experiencing at least one of various preoperative complications, or elderly, from previous reports showing that elderly patients tended to have a thrombosed false lumen after initial surgery for AAAD.[8]

Ten-year survival rates ranged from 37% to 71% in previously reported cases,[11,15–18] 77% survival rate at 10 years in our institution seems acceptable. DeBakey et al. reported that rupture of the distal aorta was the most common cause of death among patients with AAAD, accounting for 29.3% of 205 late deaths.[19] However, the leading cause of late mortality in this series was malignancy. Regarding incidence of the distal aorta, only 4 patients died of rupture during follow-up, all complicated by a residual, patent false lumen. Although careful follow-up is mandatory to prevent rupture of the distal aorta, the decision for further intervention for an otherwise asymptomatic patient remains a difficult dilemma. The condition of the residual, false lumen is an important factor in considering reoperation, in addition to comorbidities and aortic size. The results were satisfactory, with no perioperative deaths among 8 patients who underwent a distal reoperation. This fact may support the idea of considering reoperation for health young patients reaching aortic diameter of 55 mm. Endovascular treatment is another option reported to be recommendable especially for its characteristic of thrombus formation in the false lumen.[20] In addition, endovascular treatment can be an effective approach, even for elderly or severely compromised patients.

Compared to previous reports, this study has a shorter mean follow-up period of 4.3 years while previous reports had follow- up period of more than 10 to 20 years.[11,15–19] Larger numbers of patients with a longer follow-up period may be recommended for further studies.

Conclusions

The present study revealed that our conservative surgical strategy for AAAD seems to be pertinent with acceptable short and long-term results. Since 8 patients had died (3%) due to rupture of a false lumen postoperatively, careful follow-up for a residual false lumen may improve the prognosis of patients.

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