

The Outcome of Patients Undergoing Abdominal Aortic Aneurysm Repair with and without Cardiac Disease

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Purpose: We report the outcome of abdominal aortic aneurysm (AAA) repair with and without cardiac disease. In patients with cardiac disease, we compared staged procedures and simultaneous operations.

Material and Methods: A total of 217 patients underwent scheduled AAA repair from 1994 to 2005. When the AAA with cardiac disease was 5.0 cm or less in diameter, we performed a staged procedure. When it was more than 5.0 cm in diameter, we performed a simultaneous operation. Forty-two patients underwent simultaneous operations, and 15 had staged procedures.

Results: No occurrence of major cardiac complication was detected in any patient postoperatively. There were no hospital deaths in either the no-cardiac-disease group or the staged-procedure group. There were two hospital deaths in the simultaneous group. The estimated actuarial 10-year survival rates were $58.9 \pm 9.9\%$ and $68.2 \pm 1.5\%$ for the no-cardiac-disease group and the with-cardiac-disease group, respectively ($P = 0.85$). The 10-year survival rates were $71.2 \pm 1.6\%$ and $74.8 \pm 1.3\%$ for the one-stage-operation group and the staged-operation group, respectively ($P = 0.35$). There was no significant difference with regard to hospital deaths and late mortality rate among the groups.

Conclusion: The simultaneous operation method is a useful technique in patients having both a large AAA and cardiac disease. (*Ann Thorac Cardiovasc Surg* 2008; 14: 96–100)

Key words: abdominal aortic aneurysm with cardiac disease, staged procedure, simultaneous operation

Introduction

Patients with abdominal aortic aneurysm (AAA) frequently have coexistent cardiac disease such as coronary artery disease (CAD).¹ Cardiac disease is the principal cause of morbidity and mortality after AAA repair. In patients with a large AAA, a staged procedure results in an increased rate of AAA rupture.² In our hospital, all patients scheduled for AAA repair underwent preoperative cardiac examination and coronary arteriography. The

optimal management of AAA with regard to cardiac disease remains controversial. We have been performing simultaneous operations on AAAs of more than 5.0 cm in diameter with cardiac disease and a staged procedure on AAAs of 5.0 cm or less in diameter.

In the present study, we have reviewed the outcome of AAA repair with and without cardiac disease.

Material and Methods

From August 1994 to December 2005, we performed 217 scheduled AAA repair operations (average age 70.0 ± 7.1 years). Emergency operations for ruptured or impending ruptured AAAs were excluded in this study. The indication for AAA repair is a diameter greater than 4.5 cm. A total of 160 patients (average age 69.7 ± 7.3 years) had no cardiac disease, and 57 (26.2%, average age $70.9 \pm$

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Table 1. Preoperative characteristics of patients who underwent AAA repair

	With cardiac disease (N=57)	Without cardiac disease (N=160)	
Age (year)	70.9 ± 6.7	69.7 ± 7.3	<i>P</i> = 0.921
Male/Female	46/11	119/41	<i>P</i> = 0.372
AAA size (mm)	54.7 ± 11.7	55.3 ± 12.3	<i>P</i> = 0.509
Hypertension	40 (70.1%)	123 (76.8%)	<i>P</i> = 0.373
Diabetes	8 (14.0%)	26 (16.2%)	<i>P</i> = 0.134
Hyperlipidemia	33 (57.8%)	60 (37.5%)	<i>P</i> = 0.08

AAA, abdominal aortic aneurysm.

6.7 years) had cardiac disease preoperatively. Table 1 shows their preoperative characteristics.

When the AAAs with cardiac disease were 5.0 cm or less in diameter, we performed a staged procedure. Fifteen patients had staged procedures (Table 2). For CAD, percutaneous coronary intervention (PCI) was the first choice. AAA repair could not be performed until more than one month after PCI because the patients needed to take antiplatelet medicine continuously for a month after PCI, especially when a coronary stent was used. For patients with no indication of PCI, or those with other type of cardiac disease, we performed the cardiac operation first. AAA repair was then performed within two weeks after the operation; this was because an increased risk of postoperative AAA rupture has been observed after this period.³⁾ Five patients underwent a coronary artery bypass graft (CABG), 2 a CABG and aortic valve replacement, and 8 a PCI before AAA repair (Table 3).

When an AAA with cardiac disease was more than 5.0 cm in diameter, we performed a simultaneous operation. Forty-two patients had simultaneous operations (Table 2). From May 1994 to April 1999, we performed standard on-pump CABGs with cardiac arrest. Since June 1999, we have been performing off-pump CABGs. When the target coronary vessel was the left anterior descending branch (LAD) or the right coronary artery (RCA), we performed a reversed-J inferior ministernotomy, as we described previously.⁴⁾ Reversed-J inferior ministernotomies were undertaken in 16 cases involving off-pump CABG. We used an intraoperative whole blood autotransfusion system because of decrease needs for homologous blood transfusions (BTFs). Heparin sodium was administered throughout the CABG and AAA repair, and the activated clotting time was kept at 150 to 180 s.

For aortic valve regurgitation or a left ventricular aneurysm, a full median sternotomy was performed. Heparin sodium was given at a dose of 300 IU/kg to achieve

Table 2. Characteristics of patients with cardiac disease, a simultaneous operation, and a staged procedure

	Simultaneous operation	Staged procedure	
No. of Patients	42	15	
Age (years)	70.7 ± 7.2	72.0 ± 5.3	<i>P</i> = 0.514
Male/Female	36 ± 6	10/5	<i>P</i> = 0.136
AAA size (mm)	58.0 ± 11.3	45.3 ± 6.8	<i>P</i> = 0.204

AAA, abdominal aortic aneurysm.

Table 3. The procedure for cardiac disease

	Simultaneous operation (N = 42)	Staged procedure (N = 15)
On-pump CABG	12	PCI 8
1 vessel	3	CABG 5
2 vessels	4	CABG + AVR 2
3 vessels	5	
Off-pump CABG	27	
1 vessel	24	
2 vessels	2	
3 vessels	1	
CABG + Dor	1	
AVR	2	

CABG, coronary artery bypass graft; AVR, aortic valve replacement; PCI, percutaneous coronary intervention.

a target-activated clotting time of greater than 450 s before the commencement of a cardiopulmonary bypass (CPB). After the cardiac procedure, the skin incision was extended to the lower abdomen, and the abdominal aneurysm repair was conducted as usual while being supported by CPB.

In the simultaneous operation group, 12 patients underwent on-pump CABGs, 27 off-pump CABGs, 1 a CABG and Dor operation, and 2 had aortic valve replacements (Table 3). In the CAD patients of the simultaneous operation group, one vessel disease was most common (69.2%), rather than two or three.

Statistical methods

Data were presented as the mean ± SD. Significant differences are reported for *P* values of less than 0.05. All statistical analyses were performed using the SPSS for Windows software programs.

Results

Table 1 shows that there was no significant difference with regard to preoperative characteristics between with and without cardiac disease.

All patients underwent uneventful operations. No occurrence of acute myocardial infarction or major cardiac complication postoperatively was detected in any of the groups. In the staged procedure group, no patients had an AAA rupture before an AAA repair.

There were no hospital deaths in the no-cardiac-disease group, and there were two hospital deaths in the with-cardiac-disease group, both in the simultaneous operation group. One patient died because of renal and respiratory failure. The other had simultaneous renal cell carcinoma resection and died of brain metastasis postoperatively. There was no significant difference with regard to hospital death between the no-cardiac-disease and the with-cardiac-disease groups ($P = 0.059$), or between the simultaneous operation and the staged-procedure groups ($P = 1.00$).

Table 4 shows perioperative data of the with-cardiac-disease group. The operative time of the staged procedure groups was the total of time required for both the cardiac operation and AAA repair. The mean operative time of the simultaneous operation group was 283.3 ± 78.2 min, and that of the staged procedure group was 288.0 ± 132.7 min. The mean CPB time of the simultaneous group was 89.0 ± 33.9 min, and that of the staged procedure group was 102.0 ± 39.9 min. Eighteen patients (42.9%) had BTFs in the simultaneous group, and 5 (33.3%) in the staged procedure group. Transfusion requirements averaged 4.6 ± 2.2 units of packed red blood cell in the simultaneous group, and 3.2 ± 1.7 units of packed red blood cells in the staged procedure group. The mean postoperative ventilation time was 396.6 ± 272.6 minutes in the simultaneous operation group, and 543.0 ± 442.2 min in the staged procedure group. The mean postoperative hospital stay was 27.4 ± 14.5 days in the simultaneous group, and 30.8 ± 15.3 days in the staged procedure group. There was no significant difference with regard to perioperative data between the two groups.

In the simultaneous group, 1 patient had mediastinitis and needed an omental flap implant, 1 had multiple cerebral infarction, 1 had bleeding and needed a chest reexploration, 3 had pneumonia, and 5 had respiratory failure and needed Bipap mask supports. In the staged procedure group, 1 patient had pneumonia, and 1 had ileus.

The perioperative data of both groups were considered sufficient, and the number of patients with morbidity was within permissible range.

Late result

Figure 1 shows the Kaplan-Meier plot of the late deaths.

The estimated actuarial 5-year survival rates were $82.1 \pm 4.1\%$ and $85.3 \pm 5.2\%$, the 10-year survival rates were $58.9 \pm 9.9\%$ and $68.2 \pm 1.5\%$ for the no-cardiac-disease and the with-cardiac-disease groups ($P = 0.85$). The 5-year survival rates were $89.0 \pm 5.2\%$ and $74.8 \pm 1.3\%$, and the 10-year survival rates were $71.2 \pm 1.6\%$ and $74.8 \pm 1.3\%$ for the one-stage operation and staged-operation groups, respectively ($P = 0.35$, Fig. 2). There was no significant difference with regard to the mortality rate among the three groups.

Discussion

The coexistence of cardiac disease and AAA in the same patient is not an uncommon finding. Moreover, cardiac disease is the leading cause of both early and late mortality following AAA repair. Some cardiac screening measures exist, such as coronary angiography, stress electrocardiography, and radionuclide myocardial screening. The use of routine coronary angiography in the evaluation of patients under consideration for AAA repair has generated considerable controversy. Hertzner and colleagues have described their experience with 1,000 coronary angiograms in peripheral vascular patients. They reported that severe correctable CAD was identified in 25% of the entire series,¹⁾ and severe CAD was also identified in 31% of the AAA patients in their report. In our hospital, we routinely perform coronary angiography on patients scheduled for AAA repair. We have found cardiac disease in 26.2% of our patients. This result suggests that routine preoperative cardiac catheterization in AAA patients is a useful cardiac screening measure.

The treatment of AAA patients with cardiac disease remains controversial. Patients have two treatment options: staged or simultaneous. Some researchers have reported that coronary artery revascularization could possibly lead to an increased occurrence of postoperative AAA rupture. Durham and colleagues reported an 11% incidence of aneurysm rupture after cardiothoracic surgery.²⁾ Nora and colleagues reported a 38% rupture rate after elective colon resection in patients with known AAAs.⁵⁾ Blackbourne and colleagues have contended that elective AAA repair should be undertaken within two weeks of coronary artery revascularization because the risk of postoperative AAA rupture appears to increase after this period.³⁾ Size appears to be the best predictor of rupture. Nevitt and colleagues reviewed 176 patients with AAAs and found 16 to have had a ruptured AAA, all with aneurysms larger than 5 cm.⁶⁾ In our hospital, when the

Table 4. Perioperative data of patients of a simultaneous group and a staged procedure group

	Simultaneous operation	Staged procedure	
Hospital death	2 (4.7%)	0 (0%)	<i>P</i> = 1.00
Operative time (min)	283.3 ± 78.2	288.0 ± 132.7	<i>P</i> = 0.34
CPB time (min)	89.0 ± 33.9	102.0 ± 39.9	<i>P</i> = 0.52
BTF (units)	4.6 ± 2.2 (42.9%)	3.2 ± 1.7 (33.3%)	<i>P</i> = 0.47
Postoperative ventilation time (min)	396.6 ± 272.6	543.0 ± 442.2	<i>P</i> = 0.83
Postoperative hospital stay (days)	27.4 ± 14.5	30.8 ± 15.3	<i>P</i> = 0.92

CPB, cardiopulmonary bypass; BTF, blood transfusion.

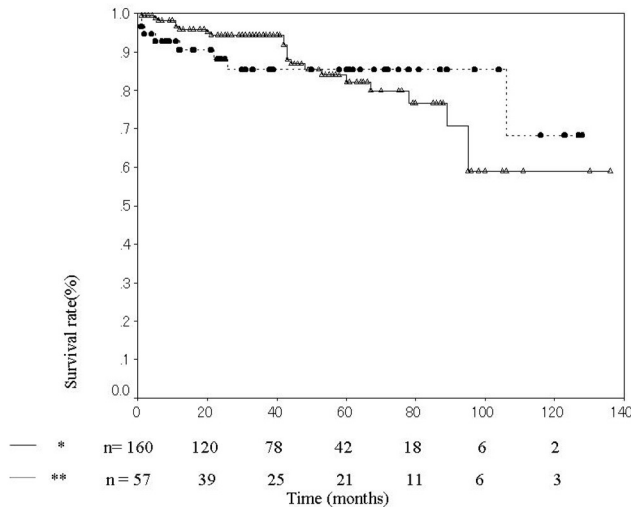


Fig. 1. Kaplan-Meier survival estimates stratified by the without-cardiac-disease group (—) versus the with-cardiac-disease group (···).

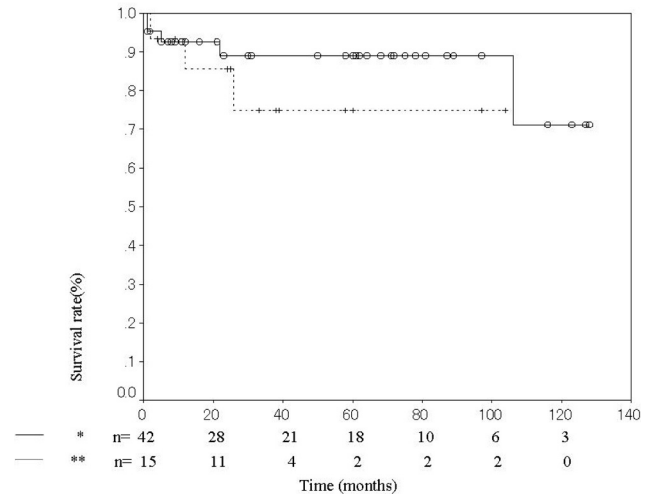


Fig. 2. Kaplan-Meier survival estimates stratified by the simultaneous-operation group (—) versus the staged-procedure group (···).

AAA is 5.0 cm or less in diameter, we adopt the staged procedure. When it is greater than 5.0 cm in diameter, we adopt a simultaneous operation. There were no ruptures in the staged procedure group under this strategy.

The hospital mortality of simultaneous operation was recently reported as 0%–12%;^{7–10} our hospital mortality of 4.7% is comparable to these reports. However, full median sternotomy and CPB are invasive to a patient undergoing a simultaneous operation of this kind. To decrease surgical stress, we have developed the following protocol: For CAD, we undertake off-pump CABG, and the reversed-J inferior ministernotomy is adopted when the target coronary is in the LAD and RCA area. The appeal of a coronary bypass on a beating heart is its avoidance of CPB, which is responsible for renal, pulmonary, and cerebral vascular complications, and also for provoking a systemic inflammatory reaction. King and colleagues speculated that the inflammatory response caused by CPB might have a direct impact on AAA dilatation, causing

further wall weakening and decreasing tensile strength.¹¹ The off-pump CABG procedure reduces intraoperative myocardial injury because of the absence of ischemic arrest. Ascione and colleagues reported a simultaneous CABG and AAA operation with and without CPB.¹² In their experience, the on-pump group had a significantly higher incidence of cardio-related events, inotropic support requirement, longer intubation time, and chest infection episodes. Total blood loss and transfusion requirements were significantly lower in the off-pump group. Moreover, as our department has reported,⁴ mini-sternotomy reduced severe postoperative pain and respiratory failure.

For valve disease or left ventricular aneurysms, we must institute CPB. After the cardiac procedure, AAA repair is performed during partial CPB. Blood lost during this procedure is saved using cardiotomy suction and retransfused via CPB. While being supported by CPB, the deleterious effects of infrarenal aortic clamping and declamping on

myocardial function can be effectively avoided.¹³⁾

However, a simultaneous operation has the demerits of its high invasiveness. We contrive to decrease surgical stress by adopting the methods mentioned above. Otherwise, a simultaneous operation avoids repeat anesthesia and prevents two separate convalescent periods. It also has other advantages. It may be cost-effective because a second hospitalization and second procedure can be avoided. Table 4 shows that the perioperative data of simultaneous operation were comparable to that of a staged procedure. Thus the method of simultaneous operation is a useful and an effective technique if performed in a careful manner.

Late survival after aneurysm repair also seems to be directly influenced by cardiac disease. Hollier and colleagues have demonstrated a 5-year survival rate of 67% and a 10-year survival rate of 40.7% in a recent series of aneurysm repairs. Late deaths were attributable to cardiac disease in 38% of the patients.¹⁴⁾ With regard to our hospital late survival, there has been no significant difference between the no-cardiac-disease and the with-cardiac-disease groups, or the simultaneous and staged procedure groups. The late survival rates were satisfactory in all groups.

In conclusion, we can perform a simultaneous operation safely on a large AAA with cardiac disease. The method of a simultaneous operation is a useful technique in patients with larger AAAs and cardiac disease.

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